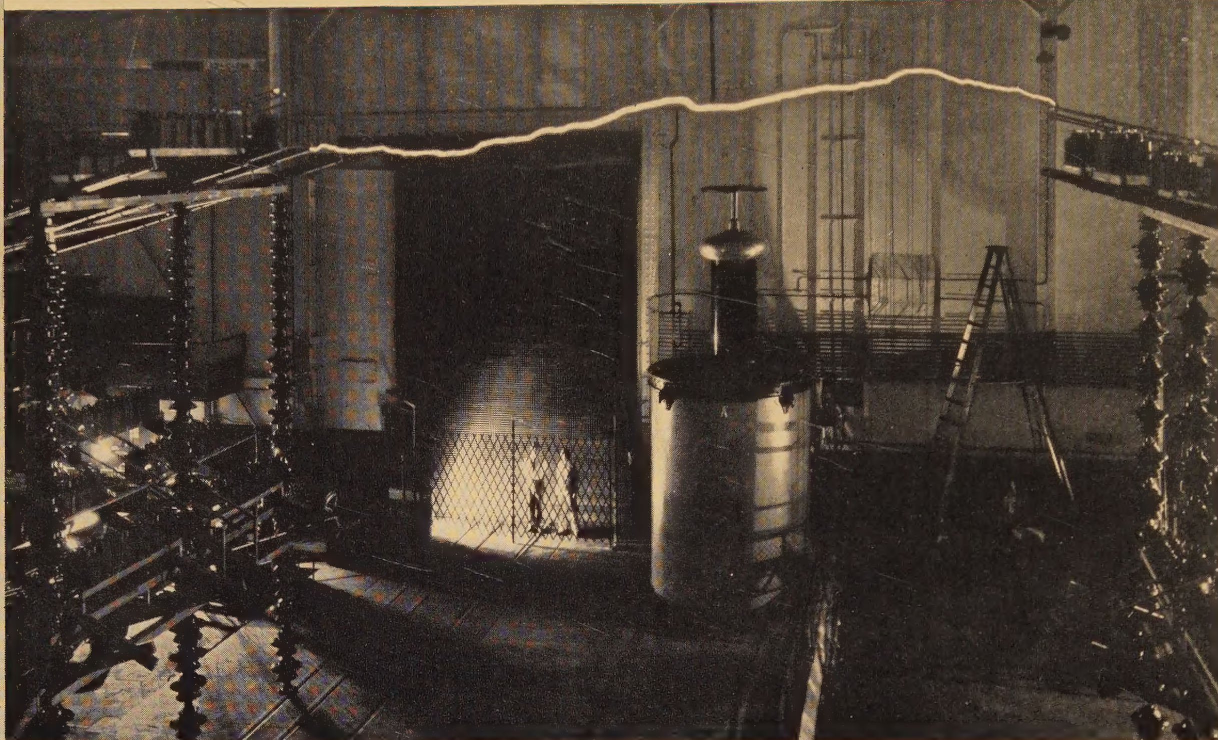
Electrical Engineering

March
1938

To Measure—LIGHTNING



A BLINDING FLASH—a crashing, deafening roar—and 10,000,000 volts of man-made lightning thunders through the high-voltage laboratory. In the almost inconceivably brief time of one ten-millionth of a second, there is set loose 12,500,000 kilowatts—more than fifty times the total electric power developed at Niagara Falls.

From hundreds of experiments like this, G-E engineers have developed instruments to measure lightning strokes. Instruments like the surge-crest ammeter, which has measured lightning currents as high as 160,000 amperes; instruments similar to the automatic oscillograph, by means of which flash-overs may be located on lines miles from the power-house.

From the surge of lightning to the trickle of electrons in a vacuum tube—these extremes illustrate the scope of G-E measuring activities. And in between are the hundreds of other instruments—ammeters, voltmeters, wattmeters, instruments to measure resistance, frequency, power-factor. Each is the product of years of experience in the instrument field; each design embodies General Electric's accomplishments in all branches of electrical science. Made in ranges to suit every purpose, G-E instruments are available for every need. They supply the scientific knowledge to make your electric power more dependable.

If you have a problem that involves the measurement of any quantity, remember that General Electric is HEADQUARTERS FOR ELECTRICAL MEASUREMENT.

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GENERAL ELECTRIC

Electrical Engineering

Registered U. S. Patent Office

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Transactions Section (*Follows EE page 146*)

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The Cover

An airplane engine casting about to be inspected by X-ray

Photo courtesy Aluminum Company of America

High Lights

Joint Use of Wood Poles. A paper in this issue reviews the safety features of the joint use of wood poles by power and telephone companies, and describes characteristics of equipment of both systems so far as they relate to the problem of protection. Factors that determine magnitude and duration of current and voltage in the telephone system resulting from a contact with power conductors are discussed, and improved methods for obtaining safety under various conditions are described (*Transactions pages 131–40*).

Current Capacity of Conductors. According to one discusser at the recent AIEE winter convention, a paper in this issue on the current-carrying capacity of rubber-insulated conductors is "not merely another paper on carrying capacity, but rather the cumulative results of years of co-operative efforts. It is regarded by many as being the logical basis for future practice and for the revision of standard tables of carrying capacity" (*Transactions pages 155–67*).

Wave Guides. Electric waves at very high frequencies (thousands of megacycles) may be transmitted through hollow conductors or even "wires" of dielectric material; the waves follow the guide with little or no external field. Experiments indicate that for one type of wave the attenuation in transmission decreases with increase of frequency and that another type of wave has attenuation nearly uniform over a band width of 4,000 megacycles (*pages 91–5*).

Carrier-Current Relaying. Two engineers concerned with the relay problems of a far-flung electric-power system have presented a comprehensive critique of carrier-current relaying equipment and systems—their favorable characteristics, their weaknesses—and suggest some criteria of operation and some ways of improving apparatus and systems now in use (*Transactions pages 118–24*).

Electronic Technology. Electron tubes perform a multitude of duties in industrial control and communication; in the United States the number of electron tubes in service is said to exceed the population of the country. Some of the trends in this highly active field have been described, and have been illustrated by descriptions of tubes and equipment now in use (*pages 100–07*).

Mechanical Uniformity of Cables. Much of the ionization in paper-insulated cables is said to occur in the voids in the layer structure of the insulation. A recently devised method enables one actually to see the voids in the layer structure and to detect other mechanical irregularities in the cable (*Transactions pages 141–54*).

Tensor Analysis. Two preceding parts of an article on tensor analysis described the intimate details of the life of a tensor. The final installment in this issue shows how some of the "secrets" of the tensor have helped to solve difficult problems in theoretical physics and engineering (*pages 108–09*).

Arc-Length Monitor. One important factor in the control of quality in an electric arc weld is the length of arc used by the welder. A new device, using two electric lamps within the helmet of the welder, serves as a constant monitor of the performance of a welding operator (*Transactions pages 115–17*).

Nominations for AIEE Offices. The Institute's national nominating committee met during winter-convention week to designate nominees for election to Institute offices for the year 1938–39 (*page 131*). Biographical sketches of the nominees are included in the "Personals" section of this issue (*pages 138–41*).

Sections Analyze Themselves. Under auspices of the AIEE Sections committee, Section "self-analysis" studies have been conducted during the past year; final report was presented and approved at a meeting of the committee held during winter-convention week (*pages 134–5*).

News 114

Winter Convention. Registration for the AIEE 1938 winter convention was the highest since 1931; attendance records also were set by the smoker and dinner-dance. Detailed accounts of the various features of the convention program are given in the news section of this issue (*pages 114–35*).

Welding Transformers. Rating of transformers used for resistance welding on the basis of the thermally equivalent continuous output, and the furnishing of more information on the name plate are suggested in order to aid in standardization (*Transactions pages 125–30*).

Electricity in Steel Mills. Modern mills for the continuous rolling of steel strip have come to depend on electric power and control, and trends now are toward the greater use of automatic control and factory-assembled switchgear (*pages 96–9*).

Young Engineers Honored. Four young engineers were honored by Eta Kappa Nu, honorary electrical engineering society, in its program to recognize outstanding young electrical engineers; two AIEE members were included in the group (*page 135*).

Edison Medal Presented. With appropriate ceremony, the AIEE Edison Medal for 1937 was presented during winter-convention week to Gano Dunn, noted engineer and past president of the Institute (*pages 127–9*).

Convention Sessions Reported. For the benefit of those unable to attend the Institute's recent winter convention, brief reports on the technical sessions and conferences have been prepared (*pages 116–26*).

North Eastern District to Meet. Lenox, Mass., will be the scene of a three-day meeting to be held by the AIEE North Eastern District, May 18–20, 1938. Plans already are under way (*pages 115–16*).

DISCUSSIONS

Appearing in this issue are discussions of the following papers:

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Number of copies this issue—22,150.

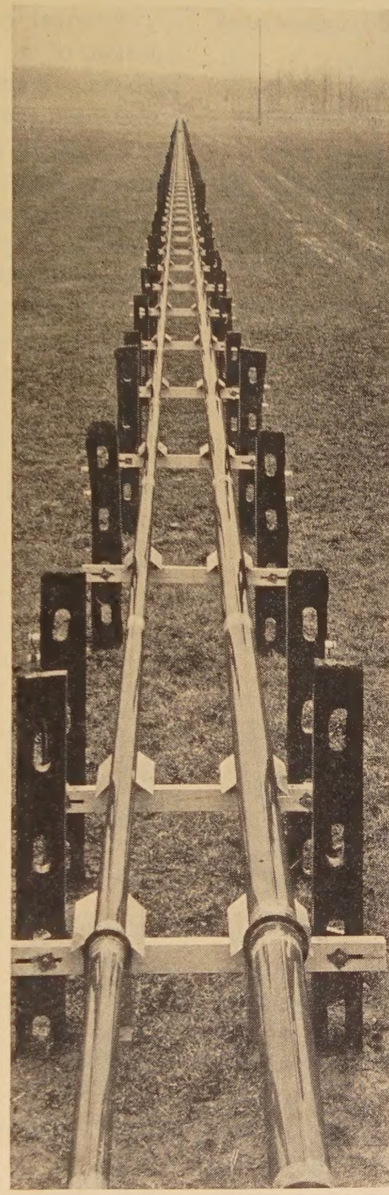
Wave Guides for Electrical Transmission

By G. C. SOUTHWORTH

The transmission of electric power at extremely high frequencies through rods or "wires" of dielectric and through metal tubes, without the usual return conductor, was predicted mathematically many years ago. Recently experiments have confirmed this theory. Wave guides offer the possibility of transmitting very wide frequency bands and consequently extremely large numbers of speech channels without the high attenuations encountered in radio; in fact, constantly decreasing attenuation with increasing frequency is predicted for one type of wave. Some of the properties of the waves and the apparatus used in studying them are described in this article.

AFTER a century of electrical communications and nearly half a century of electric-power transmission, all with substantially the same type of wire-line medium, one might well ask if there could be any new mechanisms of electrical transmission not yet utilized by the engineer. Indeed, the study of electrical transmission, conducted as it has been with both mathematics and physics, has told so comprehensive a story as almost to preclude the possibility. Nevertheless there are such mechanisms, and they have been grouped into a class, which, for convenience, is called wave-guide transmission. For the most part they are peculiar to very high frequencies—much higher in fact than have ever been used in a practical communication system. Although the existence of these waves was predicted many years ago, their actual realization is comparatively recent.

In this new form of transmission, the guiding structure used may in some instances be a hollow metal pipe, which with the present state of development might be an inch or two in diameter. In other instances it can be a somewhat smaller pipe filled with a low-loss dielectric, or it can conceivably be a cylinder or a "wire" of dielectric with no metal whatever present. All of these forms are being experimented with at Bell Telephone Laboratories.



The smallest diameter of guide, for a given mode of transmission, varies inversely as the frequency and also inversely as the square root of the dielectric constant of the internal medium. For one particular mode, on which a considerable amount of experimental work has already been done, the diameter must be at least 0.585 wave length. Such a guide usually calls for wave lengths in the centimeter range. In all cases there is no return current path, at least of the kind that is commonly assumed in ordinary transmission.

Nature of Waves

Although the waves used might seem to be radio waves, beginning as they do at frequencies higher than those generally known as ultrahigh frequencies, little or no correspondence actually exists, for radio and wave guides follow quite different laws as regards both the velocity of propagation and attenuation per unit length. In order to facilitate a proper understanding of wave-guide transmission, it is desirable to adopt the Poynting concept. As applied to the wire-line case, it says that the actual vehicle of transmission is a wave made up of Faraday lines of electric and magnetic force guided by the two conductors and that the currents flowing in these conductors are merely incidental. If next we are willing to follow a line of reasoning that is simple but not quite accurate, we may pass very easily from one of the conventional forms of transmission to one of the newer forms. This is done in the following paragraph.

A type of conductor now in use is the coaxial cable. It is represented at *A* in figure 1 as transmitting a wave of relatively high frequency. Only lines of electric force are shown, although lines of magnetic force are, of course, also

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Written especially for ELECTRICAL ENGINEERING, based on addresses presented before the AIEE New York Section on March 23, 1937, and the Philadelphia Section on December 13, 1937.

G. C. SOUTHWORTH is a member of the research department of Bell Telephone Laboratories, Inc., New York, N. Y. He holds the degrees of bachelor of science from Grove City College, and doctor of philosophy from Yale University. After spending five years as instructor at Yale, he joined in 1923 the development and research staff of the American Telephone and Telegraph Company, where he coordinated various short-wave radiotelephone development activities. He was transferred to the Laboratories in 1934. Doctor Southworth is the author of several papers on wave propagation, antenna arrays, and earth currents. He was DeForest lecturer at Yale University in 1927 and 1930, and was a member of the Washington International Radio Telegraph Conference in 1927. While an instructor at Yale he did some of the earliest work with continuous waves at ultrahigh radio frequencies.

present, for they are essential to the very existence of the wave. The latter lines consist of circles coaxial with the conductors and therefore perpendicular to the longitudinal sections shown. If the frequency is sufficiently high, new but somewhat related types of waves also may be propagated along the coaxial conductor. An example is shown at B. If now the assumption is made that the central wire and its associated

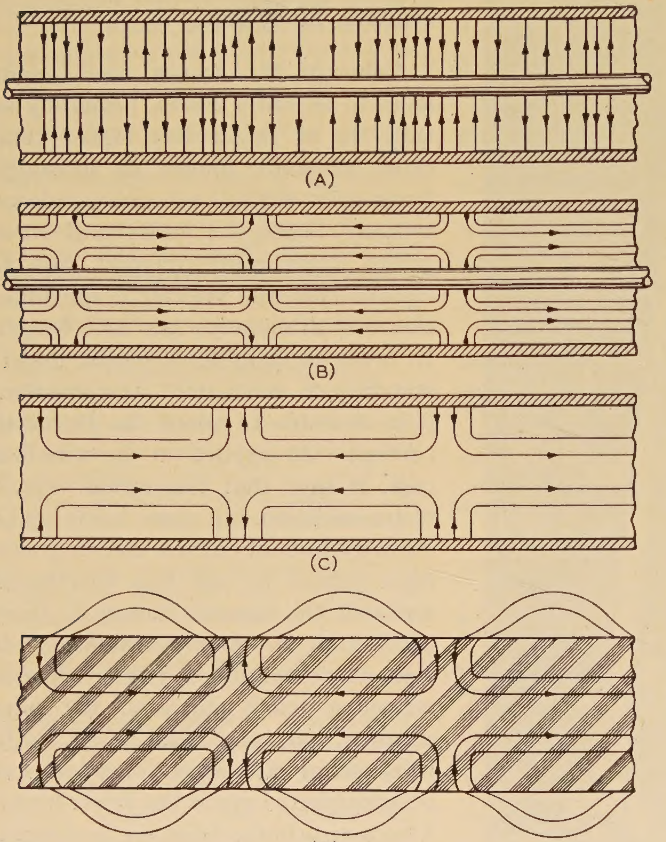

Figure 1. Some forms of waves that may be propagated over guides, showing successive steps from a form of wire line now in use to a "wire" made of dielectric material

lines of force are removed, there remains the very simple configuration shown at C. This is one of the newer forms of guided waves already mentioned. It not only transmits power but also actually gives rise to lower attenuation at these extremely high frequencies than if the central wire were present.

If the pipe be filled with a medium of substantially higher dielectric constant than the outside space, many of the lines of force will close within the dielectric instead of terminating on the shell. The outside conductor may then be removed leaving only a nonconductor as a guide as shown at D in figure 1.

Although this reasoning indicates a remote similarity between the conventional coaxial conductor and the wave guide, this view must not be accepted too generally, for as will be indicated soon, there are other types of guided waves that do not show this resemblance. It must be remembered too that not only are the guiding structures different in the two cases but also entirely different ranges of frequencies usually are involved.

Types of Waves

Many wave configurations may be propagated through a cylindrical guide, each corresponding to a particular solution of a differential equation appropriate to the problem. Four that have been used for experiments are represented pictorially in figure 2. This is for the particular case of a guide sheathed by a metallic conductor. They are designated arbitrarily as E_0, E_1, H_0, and H_1, all of which behave differently even in the same wave guides. As already explained, the E_0 wave is somewhat similar to the wave propagated by ordinary transmission over a coaxial conductor. In a somewhat similar way, the sec-

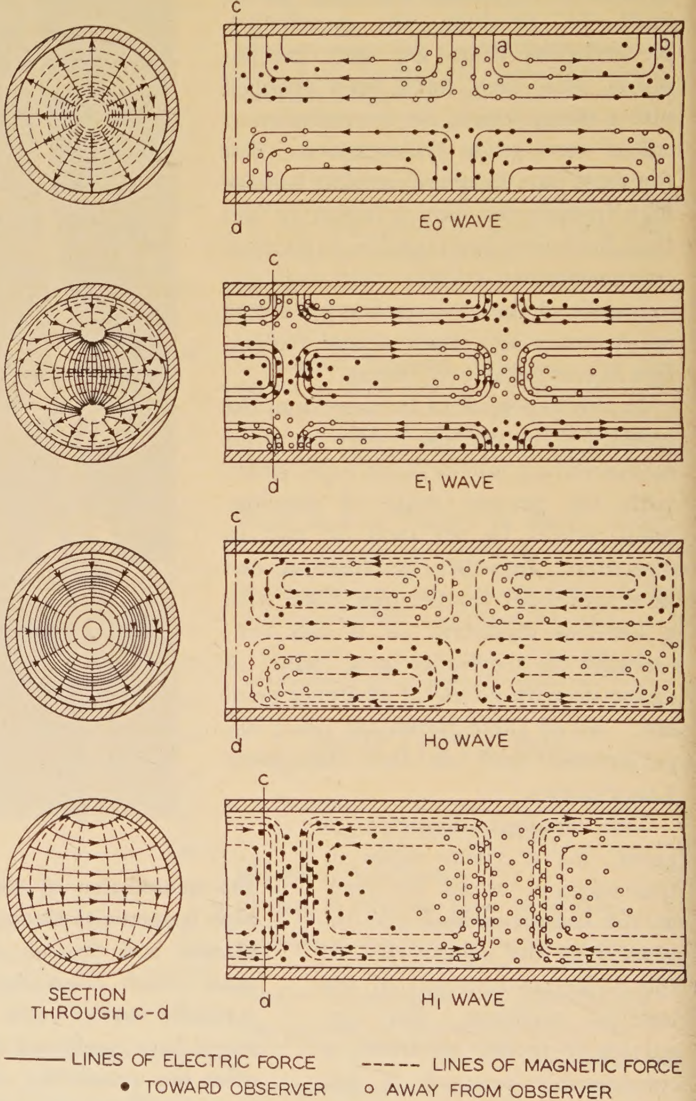

Figure 2. Approximate configuration of lines of electric and magnetic force for four types of wave-guide transmission; similar waves may be propagated through a cylinder of dielectric material

Propagation is assumed to be directed to the right and away from the observer

ond or E_1 wave resembles the shielded pair sometimes used in ordinary engineering practice. The two others, H_0 and H_1, are, roughly speaking, counterparts of those already mentioned except that their magnetic and electric lines are interchanged. They do not, however, have counterparts in ordinary engineering work.

Experimental Investigation

The wave guides used in the experimental investigation of this field have ranged from cylinders of water a few feet long, using either metallic or insulating tubes, to pipes 1,250 feet long and having diameters of four and six inches. More recently, flexible metal conduit about the same size as the lead sheath of an ordinary telephone cable has been used. Measurements have been made of the velocity of propagation, attenuation, and the cutoff frequency of the guide. The last is the frequency below which waves will not be transmitted. Suitable apparatus must, of course, be used for launching as well as for detecting and measuring these several waves.

Source of Waves

Conductor arrangements suitable for launching the various forms of guided waves are shown schematically in figure 3. Component parts of a generator for producing H_1 waves are shown in figure 4B. Although a positive grid or Barkhausen tube is shown, both magnetrons and

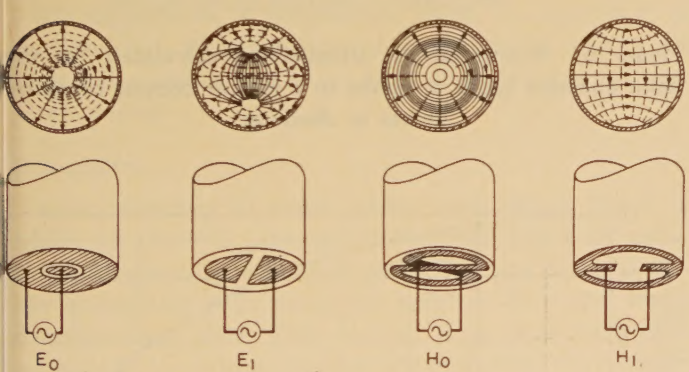

Figure 3. Conductor arrangements used in launching various forms of guided waves

the more conventional negative grid tubes have been used. These tubes will operate most effectively in a properly proportioned resonant chamber of the type shown in figure 4C. The earlier wave-guide investigations involved frequencies around 300 megacycles but more recently the range has been extended to nearly 10,000 megacycles [wave length (λ) = three centimeters].

Reflection of Waves

Guided waves, like those in free space, are readily reflected by metallic surfaces. In applying this principle to wave-guide practice, it is often convenient to make the reflector a tightly fitting piston that may be moved along the guide as needed. At other times only partial reflections are needed. In this case a metal disk with a hole cut in the center is suitable. These two forms of reflection are sometimes combined in a single unit to form a resonant cavity such as shown in figure 4C. Such a chamber may, at certain adjustments of length, have properties analogous to those of an ordinary resonant circuit made up of a coil and a capacitor, and accordingly it is useful in a variety of ways. One very simple application is that of a wave meter. For this use it is convenient to equip the piston rod with a scale and vernier from which

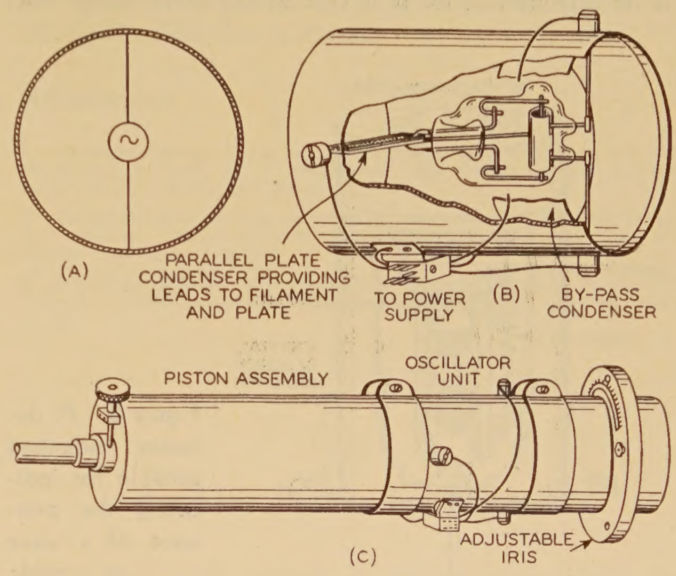

Figure 4. Various component parts of a wave-guide generator

A—Schematic representation
B—The oscillator unit
C—Complete generator including oscillator, piston, and iris

successive positions of resonance may be read. In this case the wave power for producing resonance enters through the iris opening. Resonance is indicated by a meter connected to a crystal rectifier such as shown in figure 5.

Other interesting reflection effects may be produced by certain configurations of conductors. For instance, a piston made up of a grid of parallel wires is a good reflector of H_1 waves so long as the conductors are kept parallel to the lines of electric force but it is a poor reflector when the wires are arranged at right angles thereto. Similarly, a grid of radial wires reflects selectively the E_0 wave while a grid of coaxial circles reflects the H_0 wave.

The Tuned Receiver

By replacing the oscillatory source in figure 4 by a suitable indicator, the wave generator previously described becomes effectively a simple tuned receiver. A crystal detector mounted within the tube may be connected to an external galvanometer, and if appropriately located along the length of the chamber, will absorb substantially all incident power. It may be said that such a receiver terminates a long wave-guide line in its charac-

teristic impedance. By means of probes using crystal detectors as indicators, the configuration of the waves appearing at the open end of a guide may be determined. The crystal rectifiers mentioned here are merely typical of the various detectors that may be used. Small vacuum tubes are also useful.

Fundamental Properties

Attenuation

Perhaps the most important property of a wave guide is its attenuation, for it is this among other things that

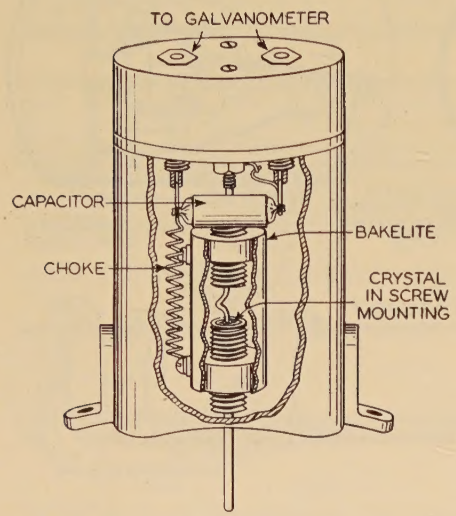

Figure 5. A detector mounting suitable for indicating the presence of a wave in a guide

determines practicability. It may be calculated for cases where the fundamental data are sufficiently well known, or it may be measured. Figure 6 shows curves for the variation of attenuation with frequency for one particular set of conditions. These curves are calculated. The experimental work already done on attenuation, however, has given results altogether in keeping with the calculation. Work done at or near cutoff for all four types of waves confirms their descending characteristics at these points. The type of wave designated as H_0 appears to have a descending attenuation characteristic at all frequencies above cutoff. This suggests that very low attenuation may be realized merely by raising the frequency. However, for structures having reasonable dimensions, these low attenuations can be obtained only from frequencies that are above those now readily available. For the other three types, wave guides when operated at extremely high frequencies may be seen to be somewhat similar in their behavior to ordinary conductors, but they depart radically at frequencies near cutoff. At the minimum of the H_1 curve, transmission is flat to half a decibel per mile over a band width of 4,000 megacycles.

Velocity

That the velocity of electric waves over ordinary conductors, immersed in a particular medium, is substantially that of light for that medium is well known. It is the velocity of light in free space divided by the index of refraction (square root of dielectric constant). It is also dependent to a small extent on the resistance and permeability of the conductors themselves. The velocity of propagation in wave guides depends not only on these properties but also on the dimensions of the guide as well. The phase velocity of guided waves in a material having a dielectric constant of 81 has been found to vary from

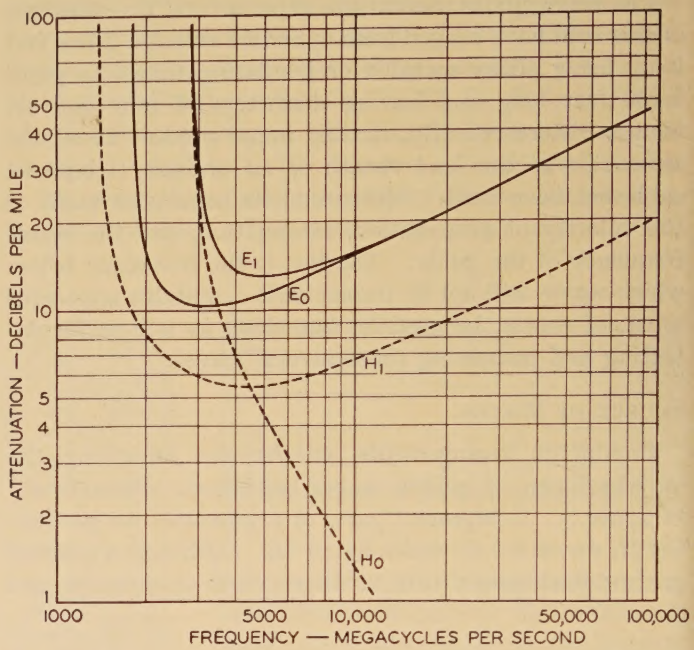

Figure 6. Representative attenuations calculated for the more common types of waves in a hollow copper pipe five inches in diameter

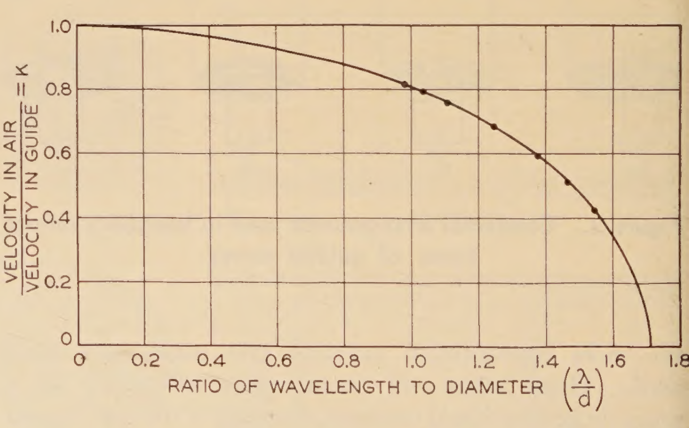

Figure 7. Velocity ratio for the H_1 type of wave in a hollow metal pipe

one-ninth that of light in free space, at the highest frequencies, to values approaching infinity at the lower frequencies near cutoff.

Figure 7 is based on calculations for a hollow conductor with air dielectric propagating the H_1 type of wave. The experimental data (plotted as points) were obtained on hollow cylinders from four to six inches in diameter

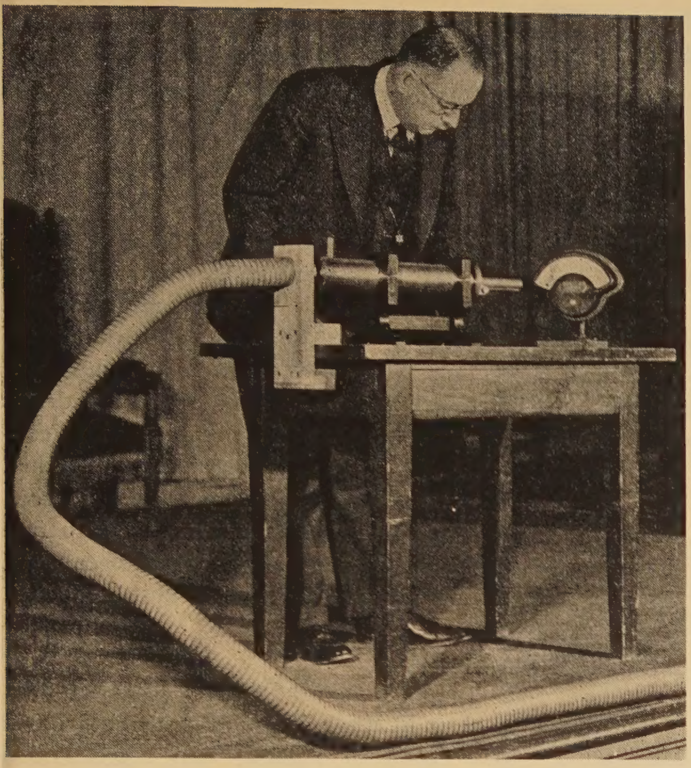

Figure 8. Experiments in progress at the end of a wave guide made of flexible metal tubing

and at frequencies extending from 1,500 megacycles to 2,000 megacycles, a wave-length range of from 20 to 15 centimeters. Relative velocity was determined from the length of standing waves set up in short sections of these wave guides.

RADIATION

Discontinuities in wave guides, particularly those in which no shield is present, tend toward losses by radiation. Radiated power issues from the open end of a hollow conducting pipe much the same as do sound waves from a hollow tube. The ends of these pipes have been expanded into horns, thereby obtaining directive effects very similar to those common in acoustics.

Uses of Wave Guides

Wave guides have definite limitations, and their commercial use cannot yet be predicted. As stated previously, the diameter of the hollow pipe that may be used is directly proportional to the wave length, and for a pipe that is at all convenient in size, the frequencies are the highest that have yet been tried for radio. Although the diameter might be reduced if the pipe could be filled with a suitable insulator, the necessary medium that will incorporate high dielectric constant with sufficiently low losses is not yet readily available. Low attenuation probably could be had with much smaller pipes by the use of H_0 waves, but this calls for an even higher range of frequencies. For long distance transmission, the art is not yet sufficiently advanced at these extreme frequencies to permit a satisfactory evaluation of practical use. For transmission over very short distances, however, or for use as projectors of electric waves, or as selective circuit elements, wave guides are extremely attractive.

The transmission of wide bands of signals bearing intelligence is, of course, one possible application. But this method must compete with other and very successful systems now in use. For the commercial success of a scheme of this kind, it is not sufficient that it be an alternate method. It must either perform some new and useful task not previously possible or it must do an old task better or do it more economically. The future of this new guided wave technique naturally will depend on the results of further research.

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2. TRANSMISSION OF ELECTROMAGNETIC WAVES IN HOLLOW TUBES OF METAL, W. L. Barrow. *Proceedings* of the Institute of Radio Engineers, volume 24, October 1936, pages 1298–1328.

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Boulder Power for Nevada

FOR THE dual purpose of serving immediately the Pioche mining district in Lincoln County, Nev., near the Utah line, and to provide for the possible future development of electrometallurgical establishments near the Boulder end of the line in Las Vegas Valley, some 165 miles of new transmission line have been built and placed in service. As part of a state-wide plan to utilize Nevada's $18^3/_4$ per cent share of energy from Boulder power house, this line and associated substations have been built by the Lincoln County Power District No. 1, a quasi-municipal corporation of Nevada.

Energy is being furnished from the four 82,500-kva units of the Los Angeles Bureau of Power and Light in the Nevada wing of the Boulder power house, but is scheduled eventually to be supplied by generating units to be placed in operation on the Arizona side. Built for ultimate conversion to 138 kv, the line is now operating at 69 kv. The present capacity of the line is given as 5,000 kw, which may be increased to about 9,000 kw by the eventual connection of a synchronous condenser at the receiving end.

Energy transmitted by the Boulder-Pioche line is purchased under a 20-year contract with the Colorado River Commission of Nevada, at 2.59 mills per kilowatt hour; the Commission in turn has a contract with the United States Bureau of Reclamation. Eventually the line may be extended to the copper camps in White Pine County, near Ely, about 110 miles farther north.—From "Boulder Power Reaches Pay-Dirt," by H. W. Crozier (A'03, M'12) consulting engineer, Las Vegas, Nevada, *Electrical West*, January 1938 issue.

Trends in Steel-Mill Electrification

By L. A. UMANSKY
MEMBER AIEE

Increasing demand for sheet steel in the automotive, canning, and welding industries has caused the development during the last decade of mills for the continuous rolling of steel sheets as wide as 96 inches. Electrical power and control are used exclusively, and now influence the design of the mechanical equipment.

ROLLING-MILL practice has undergone a true revolution during a period of some ten years, beginning about 1926. The electrical equipment had to adapt itself—and adapt itself quickly—to the new ways and means of rolling steel. New types of equipment were designed, and many new problems were created and solved.

Now, what is this new revolution? To define it in a few words, it is the rolling of flat products, such as sheet and tin plate, in a strip form. The demand for these flat products grows steadily. The automotive and canning industries alone account for a great portion of this increase, while the ever-increasing application of electric welding has contributed further to the greater use of flat rolled steel for fabricating purposes.

It would have been economically unsound, and therefore impossible, to continue to roll sheets on the old-fashioned hand mills in short pieces with finished lengths of six or seven feet. Instead of this, the continuous wide hot-strip mill has been developed.

Space does not permit following this extremely interesting development step by step, but a description will be given of a modern mill of this kind as it now exists.

Hot-Strip Mill

Figure 1 shows an elementary diagram of a modern hot-strip mill. A slab is reheated in a furnace, and is delivered to the mill. This slab may be from three to six inches thick, and may weigh from 5,000 to 12,000 pounds. It is passed first of all through a pair of so-called "scale-breaking rolls" which break up the surface scale, which is washed away by powerful water sprays. The slab is then passed in succession through the four roughing stands, which gradually reduce its thickness and increase its length in proportion. Conventional practice now is so to space these stands that the slab is never in more than one stand at the same time. These roughing stands ordinarily are driven by constant-speed a-c motors, of either the synchronous or induction type. The latter type is chosen where flywheels are needed to cope with high peak loads of relatively short duration. Units of 3,000 or 3,500 horsepower are common.

After the slab has been elongated on the roughing stands, it is passed in quick succession through six finishing mills, closely spaced, and working simultaneously on the elongated strip. Adjustable-speed drives are essential. D-c motors having a speed range of not less than two-to-one ratio by field control are used universally. Power is furnished from two or three synchronous motor-generator sets. Ward-Leonard control for starting and additional speed control is employed.

Adjustable-speed a-c drives have long ceased to be considered for this application. They would be more expensive, would take more space, and would require more elaborate high-voltage switchgear, which is a large factor because of the high interrupting capacity of the oil circuit breakers.

Electrical Problems

The capacity of individual d-c motors reaches 5,000 horsepower; total generator capacity may reach 21,000 kw. Each new mill being put in service is an effort to improve on its predecessors. For instance, several mills, capable of rolling material up to 75 inches wide at speeds up to 1,350 feet per minute, were barely one year in service when newer mills rolling up to 93 inches wide and up to 2,000 feet per minute began operation. Another 98-inch mill under construction is expected to roll at speeds up to 2,100 feet per minute. These factors naturally call for ever-increasing capacity of electrical equipment.

Thus, the concentration of power in a limited space is tremendous. Considering the motor-generator sets, the finishing stands of a modern hot-strip mill take 75,000 horsepower or more of rotating machinery. Yet the electric circuits must be laid out to permit a single operator in the mill pulpit easily to hold this power under his control. The problems which such electrical equipment involves are many. For instance, the large concentration of 600-volt d-c power, with all large machines connected to the same bus and placed not more than 100 feet from each other, requires extreme precaution and skill in designing the bus structure. The short-circuit current actually may reach a value of 250,000 amperes, or more. The theoretically possible value (neglecting the contact resistance) is estimated as high as 800,000 amperes.

The ventilation of a motor room is a problem in itself. Considering the main drives and converting apparatus the losses dissipated as heat easily may amount to 4,000 kw in the motor room of a large strip mill. This heat should be removed. Air-recirculating systems were devised whereby the same air is used over and over again,

Written especially for ELECTRICAL ENGINEERING, based upon an address presented originally at the AIEE North Eastern District meeting, Buffalo, N. Y., May 6, 1937.

L. A. UMANSKY is steel-mill engineer in the industrial department of the General Electric Company, Schenectady, N. Y. He is a native of Russia, and was graduated from the Polytechnic Institute at Petrograd in 1915. In 1919 he entered the test department of the General Electric Company at Schenectady, and the following year was transferred to the industrial engineering department.

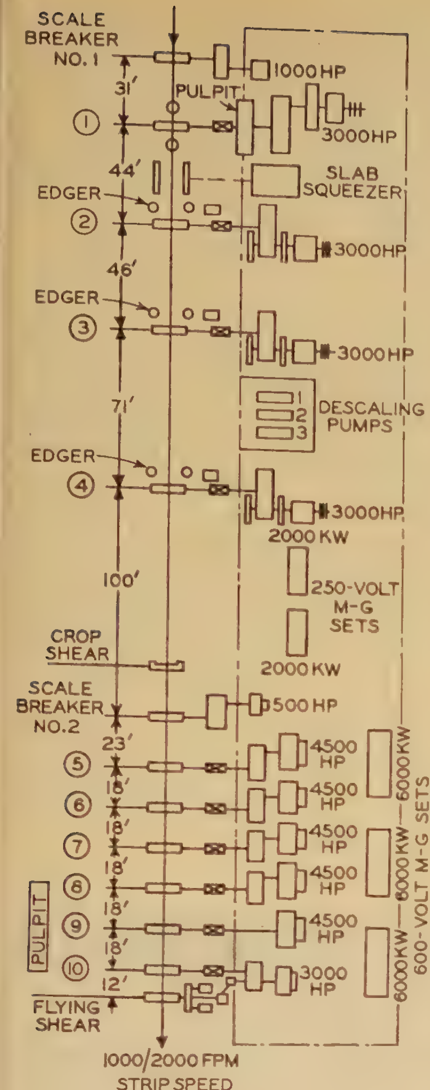

Figure 1. Typical layout of modern hot-strip mill. Heated slab, three to six inches thick, passes in succession through roughing stands 1, 2, 3, 4, each driven by a 3,000-horsepower induction motor equipped with a flywheel. After being reduced in thickness to from one-half inch to three-quarter inch and suitably elongated, the metal enters the six finishing stands, driven by adjustable-speed d-c motors

Figure 2. General view of finishing stands of hot-strip mill

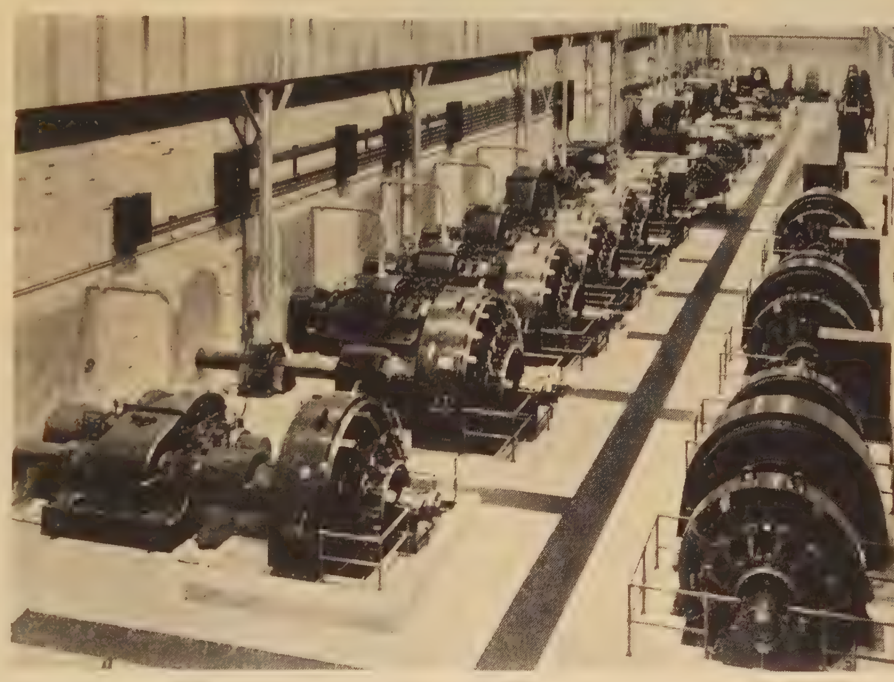

Figure 3. General view of motor room of hot-strip mill illustrated in figure 1

and heat is removed from it by means of surface air coolers. This practice is well established in treating turbogenerators; it had to be adopted to mill conditions which are much more difficult on account of the predominance of d-c machines, and subdivision of total capacity in several smaller units.

Any observing visitor to an up-to-date steel plant will not fail to notice that the mechanical equipment now is built around the electric drive. The two are fitted together rather than attached to each other. There is much truth in the saying that rolling of steel is, to a large extent, in the hands of the electricians.

Cold-Strip Mill

In no other kind of equipment is this statement nearer the truth than in the cold-strip mills. After the strip has been rolled to size on the hot mill, then pickled and washed, it is further reduced in thickness on a tandem cold mill. Figure 5 shows one such mill consisting of a group of four stands, reducing material one-sixteenth inch thick to a tin plate gauge of about 0.010 inch. The rolling is done at speeds up to 1,400 feet per minute. Each stand again is driven by a separate d-c motor. The strip is held under tension between the stands. Then, at the delivery end, the strip is coiled on a winding reel, also separately driven by a d-c motor. The latter is controlled automatically to maintain a constant winding tension regardless of the gradual increase of reel diameter during the winding process.

Figure 4 (above). 600-volt bus and air circuit breakers for finishing-mill motors and d-c generators shown in figure 3

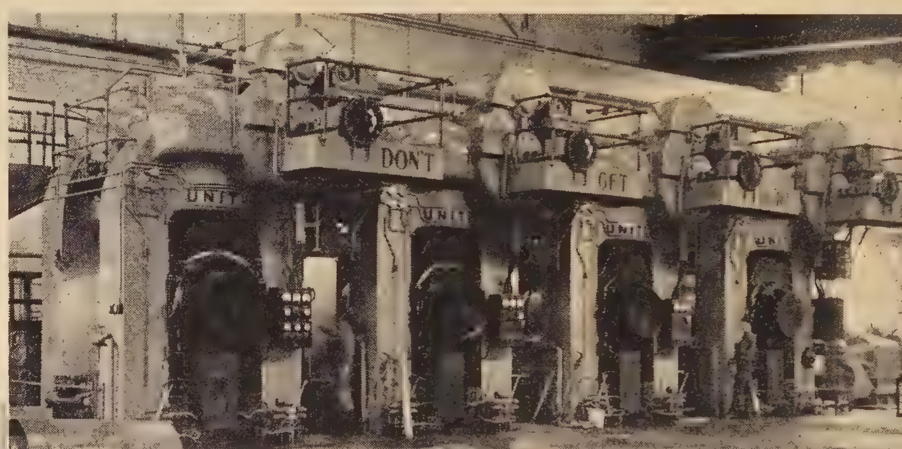

Figure 5 (right). Tandem cold-strip mill for rolling tin plate

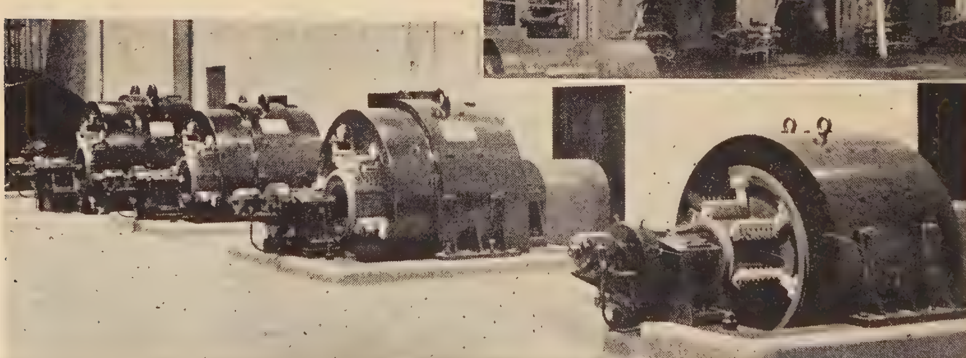

Figure 6. Four d-c motors, 500 horsepower to 1,500 horsepower, driving the cold-strip mill shown in figure 5

The strip initially is "threaded" through the several mill stands and into the reel at reduced generator voltage, and then is put under tension. After this the entire mill is accelerated rapidly, by raising the generator voltage, to the operating speeds. Speeds of 1,500 feet per minute are in use and values up to 2,000 feet per minute are within sight. This fast accelerating process with a thin strip of metal under tension is a rather delicate problem, electrically and mechanically. The required control equipment is of necessity somewhat involved. Electrical equipment is furnishing the muscles, nerves, and brains on which this process depends. Greater dependence of steel mills on the automatic electrical equipment is about the most prominent trend in this field.

Power Supply

The steel-mill electrical engineers have considerably more to do than to provide motors and control for the various machinery. This power must be transmitted, distributed, and in many instances converted or generated. In these activities, too, several interesting trends are noticeable.

For the main power supply the steel industry is leaning more and more toward the 6,600-volt 60-cycle system. Higher voltages, such as 11,000 volts or 13,200 volts, are used, and with good reason, in isolated instances, but 6,600 volts seems to be by far in the lead. Many steel plants with 25-cycle equipment on hand have to carry on with this frequency. Other 25-cycle plants put new equipment on the 60-cycle supply, with or without a frequency-changer tie. For any brand-new plant hardly anything but 60 cycles will be considered.

Again, large concentration of power in a rather limited space has influenced the type of distribution system used in some newly built steel plants. The problem is, of course, to have an uninterrupted service, limited short-circuit capacity, and low first cost. The following is a good example of the method successfully employed in several instances.

A new steel plant, built in 1929–30, purchases power from a public utility. There 24-kv feeders were carried to the steel mill from a substation some three miles away, and each was terminated at a 10,000-kva 24/6.9-kv three-phase transformer (see figure 7). The latter were

connected individually each to a 6,600-volt bus section. A synchronizing bus connects the three bus sections through suitable reactors. A failure of any transformer or feeder will not deprive the corresponding bus section of power supply, while a short circuit on any bus section will permit the other sections to maintain sufficient voltage that the synchronous apparatus will not necessarily fall out of step.

The short-circuit capacity was limited to a value well under 500,000 kva. The feature of this system is illustrated by the fact that the addition of three more transformers in 1935 did not increase materially the short-circuit capacity. In other words, the system may grow indefinitely and the originally selected oil circuit breakers may still be adequate. With the growth of steel plants the breaker capacity of 250,000 kva or 500,000 kva becomes almost universal for motor circuits and distribution.

The load imposed on the power system by a wide and fast hot-strip mill is far from being steady. Time intervals between bars are apt to be as long or longer than the duration of load; the mill speed is determined by metallurgical factors and is often selected at a much higher level than called for by tonnage requirements alone. Thus, the load on the finishing stands may easily vary within, say, 10 or 15 seconds from about 2,000 kw to 30,000 kw, and back again. This easily might cause voltage disturbances on the power system.

To correct this condition means are employed, on several recent installations, to overexcite automatically at high load the synchronous motors of the sets supplying power to the d-c mill motors. In this manner the leading kilovolt-amperes drawn from the line not only may be maintained but even increased with load, thus compensating the higher reactive drop in the line at the time of the peak load. A very much improved voltage regulation is a fitting reward for this arrangement.

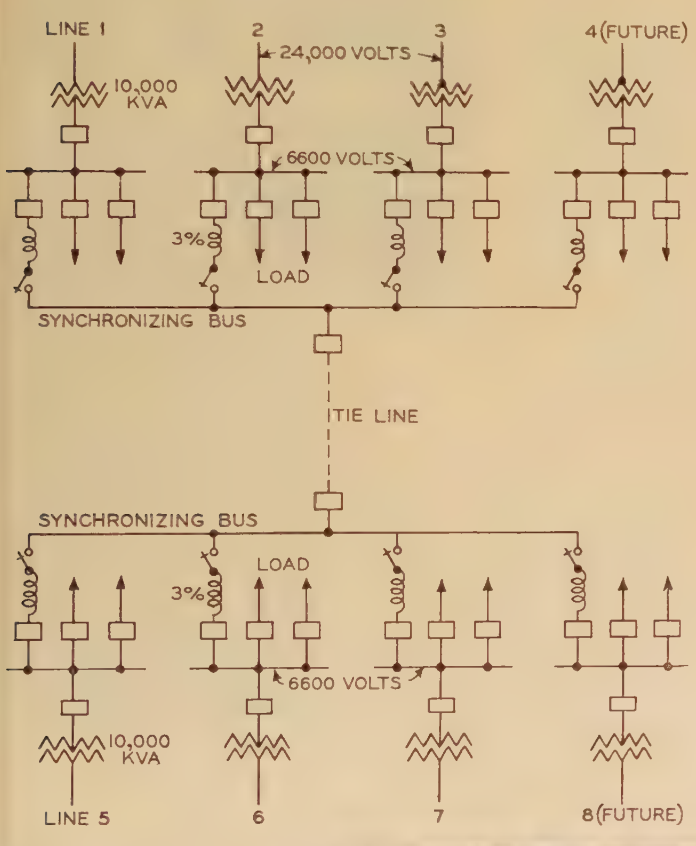

Figure 7 (above). Typical power-distribution system of a modern steel plant using purchased power

Factory-Assembled Equipment

Another growing tendency is toward electrical equipment of the completely factory-assembled type. The metal-clad high-voltage switchgear is a well-known example of this trend. Not only are the oil circuit breakers, disconnectors, instrument transformers, and other parts all built-in, but even the relays, meters, and control switches are mounted on the swinging door, making it a self-contained unit, wired and tested at the factory and ready to be put in service with no loss of time.

The same tendency spreads to other lines, such as automatic reclosing equipment for low-voltage d-c and a-c switchgear, and to the endless control panels for the numerous auxiliary drives. Panels themselves, busses, resistors, and other components are all assembled at the factory on self-supporting steel-frame structures, bringing to a minimum the erection work.

Prevailing Trends

The prevailing trends may be summarized as follows:

(*a*). Growing tendency to design the mechanical equipment and steel mill processes around the electrical apparatus.

(*b*). Tremendous concentration of electric power in a relatively limited space presenting problems of handling this power successfully.

(*c*). Greater use of automatic control, free of human element.

(*d*). Use of factory-assembled switchgear and control.

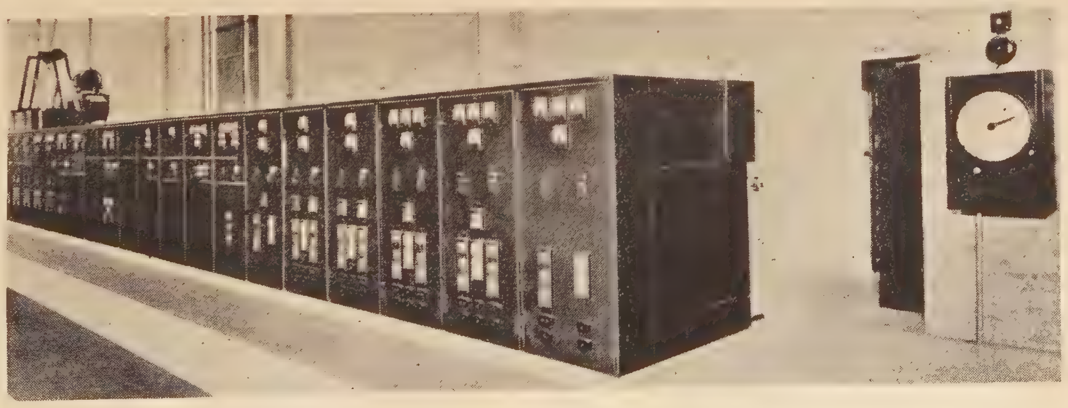

Figure 8. 6,600-volt metal-clad switchgear for large steel mill, with 500,000-kva oil circuit breakers

Recent Trends in Electronic Technology

By DONALD G. FINK

A relatively new offshoot of electrical-engineering science, electronic engineering is being projected rapidly into a multitude of uses in communication, research, industrial control; large-scale electric power transmission, using electron tubes as rectifiers and inverters, now seems to be feasible. A few of the many applications are described in this article to show the remarkable versatility of the electron and the devices used to control it.

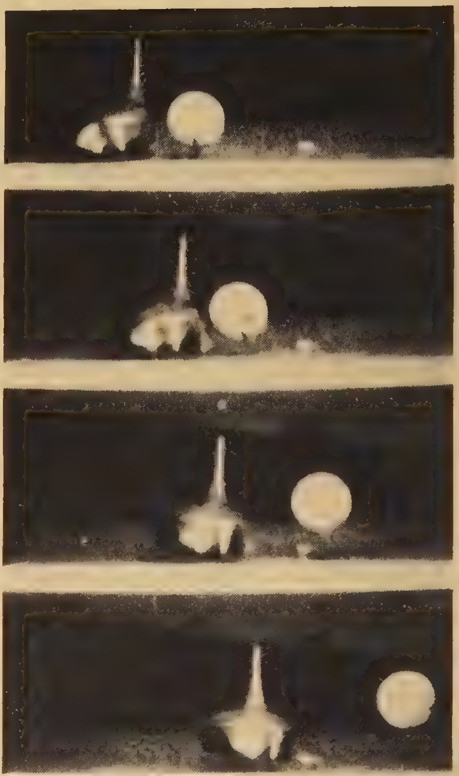

Figure 1. High-speed photographs, taken by Professor H. E. Edgerton, of a golf ball driven by Francis Ouimet. Energy ratio: 16 million ergs per gram

ELECTRONIC engineering is based on a specialized method of conducting electricity: that is, by the motion of free electrons and other freely-moving charges through a vacuum or through a gas-filled space. The utility of this mode of current conduction lies in the fact that the motions of the current-carrying charges, on which the translation of energy depends, can be much more readily controlled when they are free in space than is possible when they travel along a conductor. The province of electronics thus lies primarily in the control of electric power—particularly the control of large power sources by weak ones, and especially where continuity and extreme rapidity of control are necessary. Since many of the new applications of electricity require new types of control over generated power, it is not surprising that the electronic division of electrical engineering is at present its most active branch. The evidence of this activity is almost overwhelming. In the United States the number of electron tubes in service exceeds the population of the country. Among the achievements in electronic communication are the amplification of the voice energy in transcontinental telephone circuits a total of ten trillion times between New York and San Francisco, and the interconnection by radio of 35 million telephones in 68 different countries. A recent listing of the use of light-sensitive electron tubes contains 253 separate items, from sorting beans to timing horse races. Large-scale electric power transmission by direct current, using electron-tube inverters and rectifiers, is beginning to seem feasible. Certainly the free electron is versatile; its possibilities of application seem to be limited only by the imagination of the engineers who design, apply, and operate electronic equipment.

The purpose of this article is to examine with the reader some of the trends in this highly active field, and to illustrate these trends by descriptions of tubes and equipment now in use. For convenience the exposition is divided into three parts: first, about the electron itself; second, about electron tubes, those structures in which free electrons are produced and utilized; and third, about electron-tube applications.

The Elementary Particles

First, the electron: The electron as an entity in physics is becoming more mysterious every day, as new and apparently contradictory facts about its behavior are discovered by physicists. This tendency started in 1927 when Davisson and Germer, of the Bell Telephone Laboratories, announced that they had succeeded in causing a beam of electrons moving at high speed to undergo diffraction in exactly the same way that light waves and X rays are diffracted by gratings and crystals. In so doing they proved what de Broglie had suspected: that the electron is a wave, or at least has a distinctly wave-like aspect. But as shown later, the electron certainly is a material particle. So the electron became a wave particle or "wavicle."

Another perplexing tendency in physics is the growing family of elementary units. Students of chemistry only a few short years ago discussed just two elementary particles: the electron and the proton. Now they discuss electrons, protons, neutrons, positrons, neutrinos, and deuterons.

Latest of all, the force that causes like charges to repel each other has been found to follow Coulomb's law only if the particles are separated. Within the nucleus of the atom

Adapted from an address presented before the AIEE Boston Section, October 19, 1937.

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has been discovered a still stronger force that causes like charges to attract one another, keeping protons and neutrons in proximity.

Fortunately these new findings have not as yet penetrated engineering practice, and even in advanced design work, classical methods are still used. To the electronics engineer the electron is a very simple structure; it is a tremendous electric charge associated with a very small mass. With every gram of electrons there is associated 175 million coulombs of charge. This enormous charge-to-mass ratio of the electron is the principal reason for its great utility in electronic conduction. It makes the electron by far the most energetic and mobile particle used in engineering practice.

Neither "energetic" nor "mobile" is accepted as quantitative a term; therefore, more explicit definitions must be considered. Suppose "energetic" be defined as the adjective describing a body whose kinetic energy is large compared with its mass or weight. A rifle bullet would

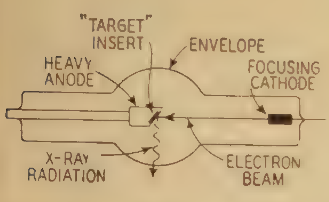


Figure 2. An electron on reaching the anode of a 100,000-volt X-ray tube has an energy ratio of 176 billion billion ergs per gram

Figure 3. Anodes of high-voltage X-ray tubes. The patches on the two at the right are caused by electronic bombardment

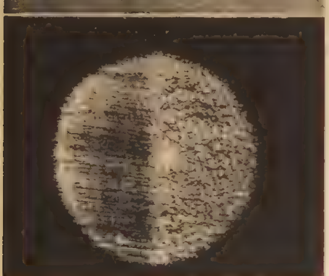


Figure 4. Enlargement (50 diameters) of the edge of one of the patches shown in figure 3. At the left is the polished metal, at the right the erosion caused by continual bombardment of high-energy electrons

qualify, as would a hard-driven golf ball. Consider the golf ball shown in figure 1. This ball is leaving a driver wielded by Francis Ouimet and photographed by Professor Edgerton with his high-speed camera, at a rate of 960 pictures per second. The pictures reveal that the speed of the ball is 186 feet per second (over two miles per minute) and that its spin is 5,000 revolutions per minute. The weight of the standard golf ball is approximately 45 grams; its radius of gyration (assuming it to be a homogeneous sphere) is 1.3 centimeters. Calculating the translational and rotational kinetic energy of the ball shows the "energetic" quantity to be 16 million ergs per gram just after it leaves the club head.

In contrast with the golf ball, consider the X-ray tube shown in figure 2. An electron leaving the negative cathode is accelerated to the positive anode by an applied voltage of, say, 100,000 volts. When this electron reaches the anode it has accumulated 100,000 electron volts of energy which, translated into ergs, is 1.6×10^{-7} ergs. The electron weighs 0.912×10^{-27} grams. Its energy therefore is 1.76×10^{20} ergs per gram. The electron, in other words, is ten million million times as energetic as the golf ball, and a golf ball driven by a master at that. In figure 3 are shown several examples of anodes. The one at the left is new; the other two were taken from X-ray tubes after hours of service. Note the small patches on the tungsten surface which have resulted from the continual electron bombardment. Under the microscope (figure 4) at a magnification of about 50 diameters the roughed or etched effect is very clear, in contrast with the nearby polished metal. Note that the scratches left in polishing the surface have been completely battered away by the impacts. Probably there is no more convincing demonstration that an electron is a material particle than this.

Another consequence of the high charge-to-mass ratio of the electron is its high degree of mobility. An electron accelerating from rest through a potential difference of 300 volts will attain a speed of a billion centimeters per second within the space of one centimeter, and it will do so in two billionths of a second. It will decelerate and come to rest in an equally short time in a retarding field. This ability to gather speed and lose it in infinitesimal periods of time explains the usefulness of the electron in rapid control systems and in generating alternating currents at frequencies of hundreds of millions of cycles per second.

Utilization of the Electron

So many words have been used in emphasizing these basic ideas of energetic and mobile behavior because they

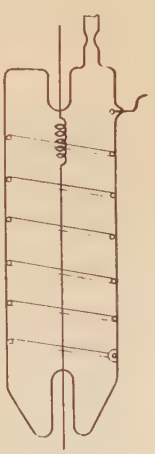


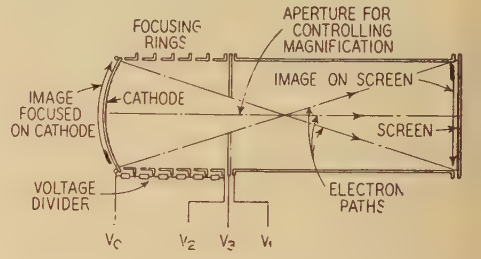
Figure 5. A simple electron microscope. The center wire emits electrons, which are attracted radially to the cylindrical wall, where they excite fluorescence, the fluorescent image being an enlarged picture of the emission pattern on the surface of the wire

underly the whole field of electronics, not because they are recent trends, which is the subject of this article. The recent trend in this case is the utilization of these behavior characteristics to the furthest possible limit. The most important example is that of ultrashort-wave radio communication, the development of which has resulted be-

cause all the long-, medium-, and ordinary short-wave regions are already occupied by more than enough radio stations. The effort to extend this particular public domain has required the development of electronic a-c generators, or oscillators, capable of producing currents at a rate of from 30 million to 300 million cycles per second (wave lengths from ten meters to one meter in length). It is at such frequencies that television service is now being developed. Only by paying particular attention to the speeds and times of flight attained by electrons and by proportioning the size and spacings of the elements within the tubes have these problems been solved. An example is a tube whose longest dimension (in its element structure) is five-sixteenths of an inch and whose over-all dimensions are almost exactly those of a large acorn.

We proceed now to the ultilization of a different form of electron behavior, the optical properties of electron beams. The development of electron optics rests on two facts: first, beams of rapidly moving electrons can, if properly handled, be made to act in many ways similar to the actions of light rays; and second, the effects of those beams can be made directly visible to the eye by the use of fluorescent screens. The oldest tube employing electron optical principles is the original Crookes tube. In this tube a high voltage, placed between the cathode and anode, causes the formation of streams of high-speed electrons (called cathode rays) to pass from the cathode to the anode. Those electrons which do not strike the anode travel past it to the glass and there excite fluorescence, making their presence known. The shadow of the anode cast by the electron beams is clearly visible; it is an example of the simplest optical phenomenon. It is a long step between this tube and another simple electron optical device constructed at Massachusetts Institute of Technology by Johnson and Shockley. The tube, shown in figure 5, is cylindrical in shape and is coated on the inside with a fluorescent coating of synthetic willemite. Along its axis is a tungsten filament, which is heated by passing a current through it. A spiral of wire makes contact with the fluorescent coating, thus allowing it to act as the anode of the tube, while the heated filament acts as the cathode, supplying free electrons. The electrons are attracted radially from the wire and fly outward toward the coated interior surface of the tube. Upon striking it they excite fluorescence, the brilliance of the fluorescence at each point depending upon the number of electrons reaching that point. The fluorescence thus makes available a visible picture of the electron distribution as it left the filament, but in greatly magnified form, the magnification being equal to the ratio of the diameter of the tube to the diameter of the wire filament. In this instance the magnification is about 400 times. Several patterns, reproduced here in figure 6, were taken to illustrate the progress of thermionic activation in a thoriated tungsten filament. The pattern at the left shows a scattering of electrons, and the hot filament down the center of the tube. As the activation proceeds, the electrons become more plentiful and the pattern increases in brilliance until finally, in the last two shown, it overshadows the light from the filament. The wavy vertical lines in the image at the right are reproductions of die marks on the surface of the wire, which apparently exercise some local effect on the emission of the free electrons. By carefully polishing the surface of the wire to remove the die marks the final electron pattern was made uniformly smooth.

Figure 7. Element structure of the Zworykin electron telescope



A still more advanced example of the formation of electron images is the so-called "electron telescope" of Doctor V. K. Zworykin, which is shown in figure 7. At one end of this tube is a curved glass plate, shaped like a watch glass. On the inner surface of this glass is sputtered a coating of caesium oxide on silver, a photosensitive coating which emits free electrons in proportion to the strength of the light falling upon it. On the outside of the plate is focused an optical image of some scene. The illumination on the plate frees electrons from the other side of the plate, forming a "picture in electrons"; that is, a plane-shaped group of electrons, the density of which is proportional to the lights and shadows of the original scene. The

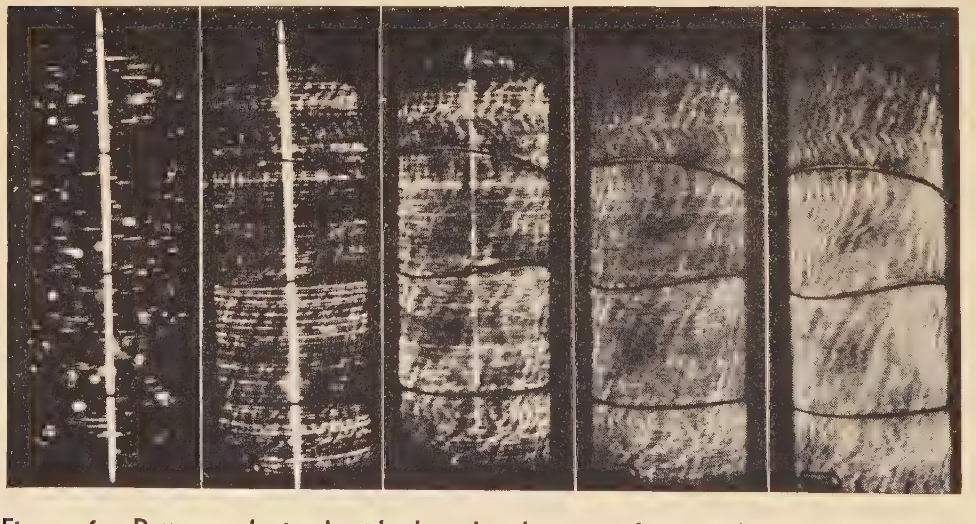


Figure 6. Patterns obtained with the tube shown in figure 5 (courtesy of Doctor R. P. Johnson)

electron image is attracted by a series of anode structures connected to a unidirectional voltage supply as shown in figure 7. Within a few thousandths of a microsecond the electrons reach the other end of the tube, where they strike a fluorescent coating of willemite. There the electron picture is transferred back into a visible picture. The result, using a favorite subject with electron-optical specialists, is shown in figure 8. This is a fluorescent image formed by the simultaneous bombardment of uncounted myriads of electrons upon a willemite surface. By changing the voltage applied to the anode structures within the tube, the image may be magnified or decreased in size, electrically. Also, and of greater importance,

Figure 8. Image formed on the fluorescent screen of the tube shown in figure 7

the device will act as a translator of invisible light into visible light, since the original photosensitive coating on the cathode may be made sensitive to infrared and ultraviolet as well as to visible light. One of the proposed uses of the electron telescope is in navigation, to see through fog, by the use of infrared light.

It is to be noted that the transfer of the electron image down the length of this tube is no mean accomplishment, since each electron in the image is attempting to fly away from all the other electrons. Like charges repel in this tube even if they do not in the interior of atomic nuclei.

The Electron Is Made to Perform Tricks Within a Tube

Now comes the second division of the field: electron tubes themselves. Here the recent trends are very well marked. So far as construction is concerned, in the larger tubes used in industrial practice there is a distinct trend toward metal envelopes. In the smaller radio receiving tubes, also, metal envelopes are useful. In the new models of radio receivers about 10 or 15 per cent of the receiver tubes are metal, the rest glass.

The importance of the metal envelope in tubes of larger size cannot be doubted. Size and cost are both factors influencing the change. In figure 9 are shown two ignitron tubes of equivalent capacity, one a glass type, the other a water-cooled metal-clad type. In the metal tube the insulation between elements is provided by Pyrex glass sealed to Fernico (an iron-nickel-cobalt alloy), which has approximately the same coefficient of thermal expansion as the glass. The tubes shown in figure 9 have a peak current capacity of 2,000 amperes and an average current capacity of 30 amperes. Their cathodes are mercury pools, in which are immersed starting electrodes or ignitors that initiate the current flow at a predetermined point in each a-c cycle. They are widely used for current control in high-speed welding equipment. A new example of an older type of pool-type rectifier is shown in figure 10—to the author's knowledge the largest electron "tube" in service. It is an Allis-Chalmers 18-anode tank rectifier, built for converter use in the Independent Subway System in New York. It is rated at 3,000 kilowatts, 625 volts. From the floor to the top of the anode radiators, it measures nine feet.

The improved technique for sealing metal to glass has had a far-reaching effect on phototube construction as well. Figure 11 shows two new phototubes with a metal receiving tube for comparison in size. The phototube envelope is a simple cylinder of glass capped at both ends with metal headers which act as the cathode and anode terminals. The seal between glass and metal, despite the fact that it measures well over an inch in length, is completely vacuum tight. This construction has resulted in manufacturing economies which have halved the prices of phototubes within the past few months.

Still another use of metal-to-glass sealing technique is the insertion of movable members in tubes. Figure 12 shows the internal structure of the so-called movable-anode tube. The header at the bottom of the picture has a very thin but airtight section through which the anode terminal, in the form of a rod, passes. On this rod inside the tube is mounted the anode of the tube. The current through the tube is very sensitive to small changes in

Figure 9. Glass versus metal envelopes in ignitron tubes of equivalent capacity

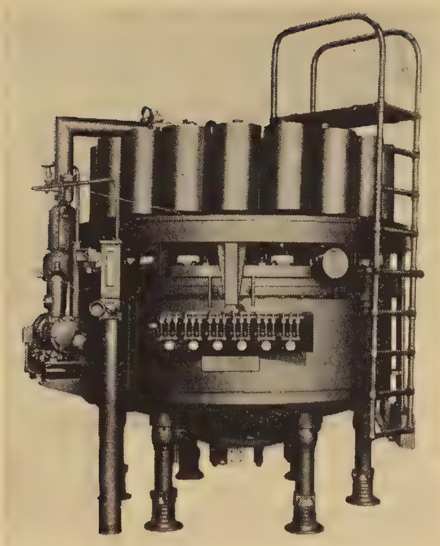


Figure 10. Power in electronic equipment: 18-phase, 3,000-kw tank rectifier used in the New York Independent Subway System

Figure 11. Metal-capped phototubes. Each metal-to-glass vacuum seal is over an inch long

physical separation between the cathode and the anode; consequently, very small mechanical displacements of the rod, external to the tube, are reflected in large current changes that can be indicated electrically. Suggested uses of the tube are as a direct-reading electronic micrometer, and as a delicate limit gauge for automatic processing of precision parts.

Multiplying Electrons

An entirely new principle in electronic tubes has grown up within the past two years—an idea with almost limitless possibilities. The principle is described by the term "electron multiplication." For some time it has been known that when an electron bombards a properly prepared metallic surface it can by the very act of bombardment release from two to ten electrons from the surface. These electrons, once free, may be collected on a nearby anode, with the result that a new current having two to ten times the strength of the original current is formed. The first practical current amplifier to make use of the multiplying principle is, so far as the author knows, that of Philo T. Farnsworth. Farnsworth's tube contained two cathodes, one at each end of the tube, and both coated with a low-work-function layer of caesium oxide, from which electrons could readily be extracted by bombardment. Between these two plates he connected a source of extremely high-frequency alternating current, the period of the alternations being approximately equal to the time of flight of the electrons between the plates. The alternations caused each plate successively to assume a positive potential with respect to the surrounding space, and hence to attract nearby electrons. The electrons hitting the plate released from two to ten new electrons for each impacting electron. This augmented group was then attracted, as the polarity of the plates changed, to the opposite end of the tube, where it struck the other plate and there liberated still more electrons. The process cumulated in geometrical progression, and the number of electrons participating in the shuttle-cock motion became so great that some must be removed before more could be liberated. This removal was accomplished by the action of a centrally located anode, to which was connected a battery supplying the power consumed by the device. This power can be used to sustain the necessary high-frequency alternations, and the tube becomes self-supporting except for the drain on the anode battery. This tube was hailed when it appeared as the first truly "cold-cathode" oscillator. It has since been used for long-distance communication, functioning similarly to more conventional oscillator tubes.

A second application of electron multiplication, of equal ingenuity, is the multiplier tube of Doctor Zworykin, shown in figure 13. The tube consists, as shown, of two sets of plates mounted in opposite rows, connected to a battery in such a way that the potential of each plate rises successively over that of its neighbor to the left. The upper tier of plates serves simply to draw electrons from the lower emitting plates. External to the tube is applied a transverse magnetic field, which causes the electrons to take the curved paths shown. As a result an original electron, freed from the first cathode by the action of light, flies in a curved path to the next cathode where it strikes sufficiently hard, on the average, to liberate five new electrons. These five in turn fly to the next cathode, there liberating 25 more, which go on to liberate 125, and so on for nine steps, producing at the last cathode no fewer than 1,953,125 electrons, which are captured by the final anode and conducted to an external load. The tube thus performs a current amplification of two million times. If the light on the first cathode is caused to vary in accordance with the light from a sound track on motion-picture film, the

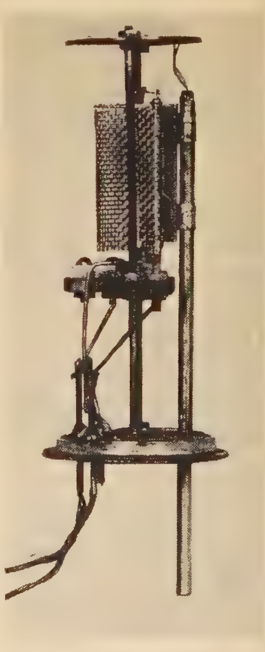


Figure 12. Movable-anode structure, in which current variations are produced by mechanical displacement of the elements

current throughout the tube will vary in the same fashion and the output current will have sufficient power to operate a loudspeaker directly. Figure 14 shows the electrode structure of a 12-stage Zworykin multiplier. A similar type of multiplier phototube is now beng developed for use with home talking-picture equipment.

Applications of Electron Tubes

The third part of this discussion, the applications of electron tubes in what may be called electronic systems, is so vast a subject that only a few applications in widely diverse fields which illustrate present tendencies in the art may be indicated.

The Hammond organ is an instrument which has figured largely in the editorial pages of the *American Organist*, the editors of which have roundly denounced it as a very poor imitation of a pipe organ, and have labeled it simply with cutting derision an "electronic." The Hammond, for all that, has had a two-million-dollar volume of business in the past two years and has appeared in such diversified musical organizations as George Olsen's Orchestra in New York, and the Boston Symphony Orchestra at Providence, R. I.

Briefly, the Hammond creates musical tones in a multitude of small a-c generators the rotating armatures of which are driven by the same shaft and hence remain perpetually in tune. Each generator produces a substantially sine-wave output of constant frequency, there being one generator for each pitch from lowest diapason to highest flute. By an ingenious channel mixing arrangement the alternating current from each of these individual sources is mixed into a single channel, the mixing being controlled by the manual and pedal keyboards and by the stop combinations of the instrument. The final mixed

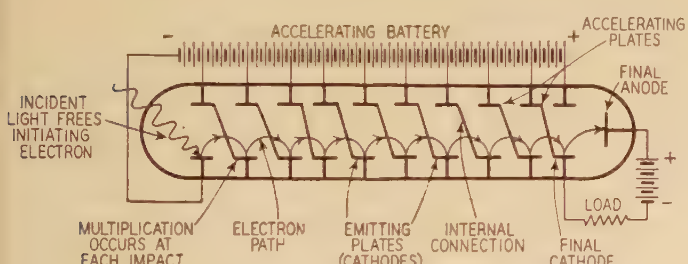


Figure 13. The Zworykin electron multiplier

signal is amplified in a conventional audio-frequency amplifier and applied to a loud-speaker. A very close imitation of conventional organ tones is thereby produced, and in addition, by the mixing arrangements provided, the organist may produce tones not available on the pipe organ at all. This is true synthetic music—lauded by some, condemned by others—but a significant event in musical history, and in electronic history as well.

Still another application of electronic amplifier technique to music is the Meissner piano, which makes a miniature piano sound like a concert grand, and then some. On the sounding board of the piano is fixed a row of flat electrodes, one electrode for each string in the register. Each electrode forms one plate of a variable capacitor, its associated string the other plate. A polarizing voltage of a few hundred volts is placed between the strings and the electrodes. As a string, or combination of strings, is struck, the resulting change in capacitance superimposes on the polarizing voltage an a-c component, the frequency and wave-shape of which correspond exactly with the note or combination of notes struck. This a-c component is

Figure 14. Element structure of the multiplier shown in figure 13

amplified and applied to a loud-speaker. The results are amazing. Without the amplifier a small piano sounds weak and flat; with it, the tone and volume range are so improved that it is hard to believe the same instrument is being played.

For the interest of those whose business is power transmission and for those to whom music is just another annoyance, the experiments of the General Electric Company with the transmission of high-voltage power by direct current may be of more interest. It needs hardly to be pointed out here that d-c transmission offers many attractions compared with the conventional a-c system. It would be a simple world if there were no system-stability problem; no power-factor-correction problem; no skin effect on conductors; if the operating voltage of insulators coincided with the peak voltage instead of a value of 30 per cent less than peak. It would be, student readers will agree, very fine if symmetrical components were not needed in the solution of transmission problems. This Utopia for transmission engineers may not be immediately at hand, but it seems to be coming. Electron tubes suitable for converting alternating current to direct current and back again at high voltage are at hand, and they are being applied in daily operation.

The manner in which they are applied is shown in figure 15. The energy is produced at alternating voltage, as it must be to obtain the high voltage necessary for economy in transmission. It is then immediately rectified in mercury vapor diodes or phanotrons. The rectified current is smoothed in reactors and then applied to the transmission line where it is transmitted, at high voltage, as direct current. At the receiving end of the line, the direct current feeds a three-phase electronic inverter circuit containing six (or more) mercury-vapor triodes, or thyratrons, which invert the direct current to alternating current at any desired commercial frequency. The alter-

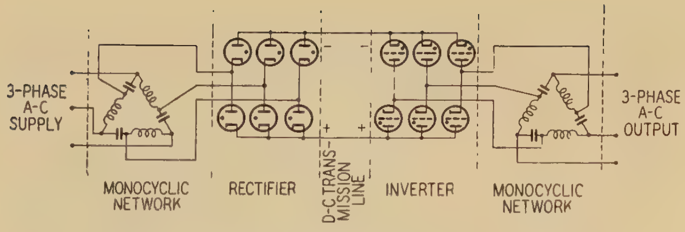


Figure 15. Outline of d-c transmission system

nating voltage is then stepped down and applied to distribution networks in the conventional manner. The losses in the rectifiers and inverters are small compared with the gains obtained from using the full conductor cross section and the higher average voltage available from given insulation.

In the a-c line at each end are shown so-called "monocyclic networks." Energy is supplied at constant voltage at the sending end, is converted by a monocyclic network for transmission at constant current, and is reconverted to constant voltage by another network at the receiving end. The constant-current operation of the d-c line serves an important purpose. When a fault occurs, the current to the fault cannot exceed the operating current, and the reduced voltage across the fault therefore must result in a decreased energy transfer. The tendency of the arc to draw a heavy current at reduced voltage is thus inhibited, and in most cases the fault clears itself almost as quickly as in an a-c system in which the voltage goes to zero twice in each cycle. An advantage not to be overlooked in the system is the ability to generate at any convenient frequency regardless of the needs of the load, and to utilize the power at any frequency convenient to the load, regardless of the generating conditions. The same idea can be applied to electric ship propulsion, in which high generating frequencies may be combined economically with low propulsion-motor frequencies.

By far the most significant large-scale application of electron optics is television, or more accurately, cathode-ray television, to distinguish it from the older mechanical type. Cathode-ray television makes use of free electrons in at least six separate and distinct ways, for "picking up" the image at the studio, for converting it into a signal, for amplifying that signal, for superimposing the signal on a radio wave, for converting the radio wave at the receiver back into signal form and for translating the converting signal back into a visible image. In the entire television system there are no moving parts whatever except electrons. Although cathode-ray television is one of the most important and fascinating of the newer evolutions of the electronics art, it cannot be discussed more than superficially here, and is best reserved for a more complete description in some later article.

Some Examples of Electronic Control Circuits

Vacuum tubes have only one important ability in control problems, and that is in cases where substantial voltage changes are available for initiating control, but where very small amounts of current are available. In other words the vacuum tube is essentially a high-impedance control device, and it serves satisfactorily only where a high-impedance control source is used as the controlling agent.

Consider, for example, figure 16. The circuit shown in *A* is a resistor and capacitor combination used for introducing time delay in electronic control problems. A voltage source (obtained from the voltage divider) is used to charge a two-microfarad capacitor through a variable resistor set at its maximum value of 50 megohms. If the voltage across the divider is 100 volts, the voltage across the capacitor will become 63 volts at the end of 100 seconds after the charging begins. If the resistance value is reduced from 50 megohms to its minimum value of 0.1 megohm, the voltage across the capacitor becomes 63 volts 0.2 second after the charging begins. Taking 63 volts as a control reference, therefore, any time delay from 0.2 second to nearly two minutes may be obtained simply by adjusting the resistor R_2. To measure the voltage across the capacitor, however, is not a simple matter, since the resistance of the measuring voltmeter must be very high compared with the charging resistor, else the capacitor will discharge through the voltmeter faster than it can charge through the resistor. The answer to this problem is a vacuum-tube voltmeter, the input resistance of which is very high. The vacuum-tube voltmeter circuit may also contain a relay for turning another circuit on or off when the capacitor voltage has increased to the reference value. The instrument shown in figure 17 has been built to accomplish this action. When the push-button is pressed, the charge of a capacitor is initiated and at the same time the power circuit is closed. When the

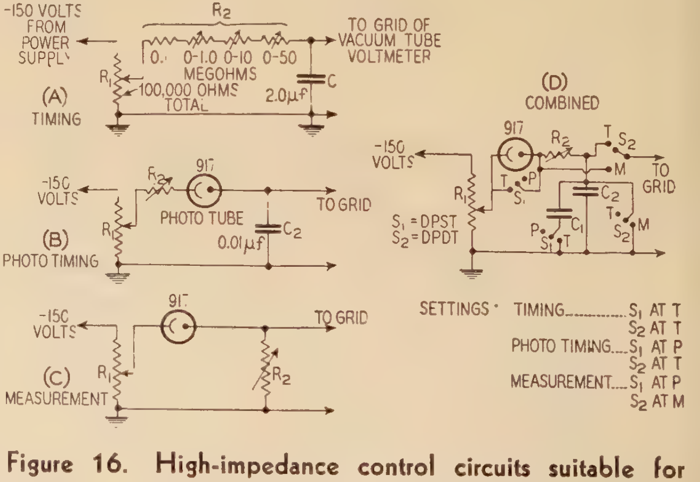


Figure 16. High-impedance control circuits suitable for actuating electronic relay circuits

capacitor voltage reaches the reference value, the relay in the voltmeter circuit breaks the power circuit, and resets the device. By adjusting the resistance dials, any degree of time delay from less than a second to well over a minute can be obtained. The use to which this particular device has been put is the timing of photographic exposures, for interior photography, using photoflood lamps, and for printing and enlarging. In enlarging its automatic operation is a great convenience since it permits the photog-

rapher to "dodge," that is, to allow denser portions of the negative to expose longer than the less dense ones, without worrying about the time of exposure. The length of time of exposure is set by adjusting the dials, which may be calibrated directly in seconds.

A rather interesting variation of the circuit is shown in *B* of figure 16. Here the capacitor is charged through a phototube operated at saturation. The voltage across the capacitor is proportional to the product of the strength of the light falling on the phototube (lumens) times the duration of the light (seconds). The capacitor voltage is, in other words, a measure of the quantity of light falling on the phototube in a given length of time. Suppose the light falling on the phototube is the same light that is exposing a piece of photographic paper. Suppose the paper is properly exposed in the highlights when it has received a quantity of light equal to ten foot-candle seconds. If the reference voltage on the capacitor is chosen to correspond to ten foot-candle seconds, the relay will act to turn the lamp off when the paper is fully exposed, not before, and not after that time. In other words, the phototube controls the exposure in terms of the quantity of light necessary to expose the paper, and it automatically compensates for changes in illumination due to negative density, degree of enlargement, variation in lamp voltage, and other variables.

A simple change of connections *C* connects the phototube across a resistor and eliminates the capacitor. The voltage across the resistor is proportional to illumination (foot-candles), not quantity of light. This device may be used as a simple control to turn on the lights as darkness approaches, or to open garage doors when headlights are flashed upon the phototube near the driveway, and for all the other uses to which the "electric eye" is put. The meter in the instrument permits reading of the relay current (the plate current of the vacuum-tube voltmeter) and hence the device may be used as a measuring instrument for time, quantity of light, or illumination.

If the pushbutton is short-circuited, the device will repeat, clicking once for every unit of light received. When the phototube is near the lamp the rate at which light energy is received is high; when it is farther away the rate is much slower and the click rate decreases.

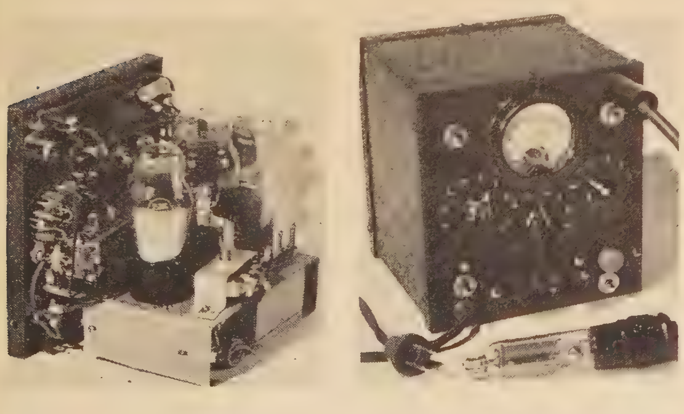


Figure 17. Electronic timing device incorporating the control circuits shown in figure 16

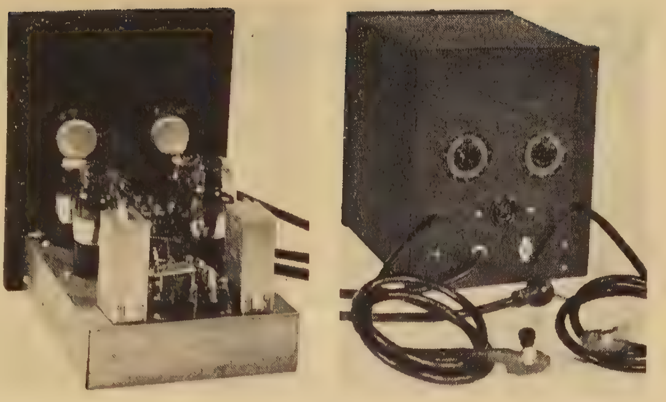


Figure 18. Two timing devices, connected in series, actuate a warning when two switches (say tread-switches in a road-bed) are closed in succession within a given time interval

The device shown in figure 18 is nothing more than two timing devices connected together, the circuit of each being exactly the same as that of the photographic "gadget," but as used without the phototube.

The device was designed and built to put into practice the suggestion of an 11-year old boy, who thought that speeding autoists might be warned by measuring their speed and turning on a warning sign if they exceeded the speed limit. When the first button is pressed, the device counts quarters of a second. If it is pressed once, it counts one quarter-second interval. Now if the second button is pressed before that quarter-second interval is over a relay is energized, turning on the lamp, and at the same time starting a timing circuit which turns the lamp off, and resets the device at the end of 20 seconds. But if the second button is pressed after the one quarter-second interval, nothing happens. In practice, the two pushbuttons are set in the road bed as tread switches, some 22 feet apart. A car traveling faster than 60 miles an hour will contact these switches in less than one-quarter second (since 60 miles an hour is 88 feet per second). Slower cars will contact the switches in a slower interval of time. The device resets itself immediately after the warning sign goes off, and it is provided with interlocks to prevent improper operation, such as operating on cars going in the wrong direction, or the possibility of a warning being thrown off by a car following the speeder. The speed at which the warning flashes can be adjusted, as can the time during which the warning remains in effect, by the two dials on the front of the cabinet.

The boy who thought of the idea suggested a warning sign reading "Slow down—you have been driving faster than 60 miles per hour." This is much more gentle than the suggestion that the device be connected to a stop light a quarter of a mile up the road. The light remains perpetually green until a speeder trips the device, whereupon it turns red. An officer of the law, sleeping in a booth nearby, is awakened by a bell on the same circuit, walks out to the motorist who has stopped for the red light, and hands him a ticket. Electronics is, in addition to all the other things it has been called in this article, perhaps a potential menace to us all.

What Is Tensor Analysis?

Part III—Applications

By BANESH HOFFMANN

In two preceding parts of this article* the tensor was hunted to its lair and tortured until it revealed its innermost secrets. Here the author shows how some of those secrets have helped to solve difficult problems in theoretical physics and engineering. Tensor analysis is not propounded as the best method of attack for all speculative problems, but is shown to offer perhaps the simplest solution of many problems requiring broad, searching analysis.

ULTIMATELY, that which determines what a thing can or cannot be used for is the nature of the thing itself. A volcano, for instance, could hardly be used instead of ice-cream; it's too warm. Nor could a tensor ever be an adequate substitute for mother's milk; not even a whole tensor field!

If we want to know the possible uses of tensors we must first know what tensors are. This we found in the preceding parts. On the one hand, tensors pertain to mathematics, and die if deprived of co-ordinate systems. On the other hand, their chief function is to represent mathematically certain objective entities which can exist independently of co-ordinate systems. It is reasonable to conclude that tensors will enter, openly or surreptitiously, whenever we represent such objective entities mathematically with the aid of co-ordinate systems.

Take, for instance, the free motion of a rigid body; and, in particular, its rotation. As is well known, this is best treated relative to the center of gravity of the body, the effect of the external couples depending entirely on the inertial properties of the body relative to this point. To discuss these inertial properties mathematically we have to introduce reference axes and calculate the moments and products of inertia of the body relative to them. The interesting thing is that these moments and products change with every change of reference axes though the inertial properties must remain unaffected; did they not, the body would not know how it ought to move. Here is a clear opportunity for a tensor, and sure enough the three moments and the three products of inertia are, in fact, the components of a second-rank covariant tensor, just like a g_{ab} in three dimensions.

Again, consider the stress in an elastic body under stress. Under given forces the stress is quite definite. Yet to express it mathematically we introduce reference axes and break the stress at each point of the body into six components which change with each change of axes. It does not surprise us that they turn out to be the components of a second-rank covariant tensor as in the previous case. There is a difference here, though, for we cannot know the stress in an elastic body until we know the stress tensor belonging to each point of it. This means that the stress is represented not by a single tensor but by a whole tensor field.

The simplest examples of the uses of the differential properties of tensors are to be found in the ordinary vector calculus. The divergence of a vector **V**, according to the vector calculus, is the scalar

$$\operatorname{div} V = \frac{\partial V_x}{\partial x} + \frac{\partial V_y}{\partial y} + \frac{\partial V_z}{\partial z} \tag{3.1}$$

This, however, is true only in Cartesian co-ordinates. In cylindrical polars (r, θ, z), for example, the divergence of V is *not*

$$\frac{\partial V_r}{\partial r} + \frac{\partial V_\theta}{\partial \theta} + \frac{\partial V_z}{\partial z} \tag{3.2}$$

If we wish to write the divergence in a form correct under all circumstances we must use a covariant derivative. The divergence of V^a is really the contracted covariant derivative

$$V^a{}_{,a} \tag{3.3}$$

summed, of course, over a. This form is valid for all co-ordinate systems.

The Laplacian of **V**, usually written

$$\nabla^2 V = \frac{\partial^2 V_x}{\partial x^2} + \frac{\partial^2 V_y}{\partial y^2} + \frac{\partial^2 V_z}{\partial z^2} \tag{3.4}$$

should also be written in terms of covariant derivatives. It is defined tensorially as

$$g^{ab} V^c{}_{,ab} \tag{3.5}$$

The curl of a vector is of even more interest. It is not a vector at all, but a second-rank tensor of the form

$$V_{b,a} - V_{a,b} \tag{3.6}$$

This being the case, we may well wonder why the vector books insist that it is a vector. The apparently irrelevant reason is that they work in three dimensions. It so happens that in three dimensions the curl of a vector has precisely three distinct components. This gives the curl a chance to masquerade as a vector. In two dimensions, however, it has only one distinct component, while in four it has as many as six.† Only in three dimensions can it pretend to be a vector.

There is hardly a branch of physical science which is free from tensors. Such subjects as hydrodynamics and electromagnetic theory with their extensive use of vectors are chock full of tensors of the first rank, while in so far as they involve curls, and cross products, they in-

*Written especially for ELECTRICAL ENGINEERING, this is the third and concluding part of an article which began in the January 1938 issue, pages 3–9; Part II appeared in the February 1938 issue, pages 61–6.

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The author is especially indebted to Professor E. E. Dreese and Doctor K. Y. Tang, of The Ohio State University, and to Professor C. H. Willis, of Princeton University, for their many valuable suggestions, and expresses his warmest thanks to them and to the many other friends who encouraged him in the writing of this article.

†This is all fully explained in the textbooks on tensors.

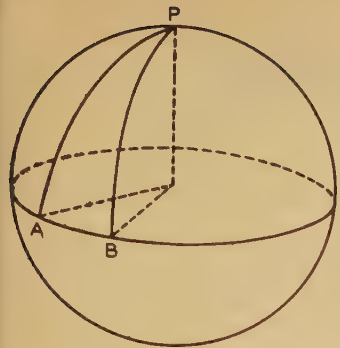

Figure 6

volve second-rank tensors too. The matter goes even deeper than this, since there is practically no escaping the ubiquitous metrical tensor g_{ab}.

Often the old vectorial methods will suffice. In electromagnetic theory, though, an event occurred which altered this convenient situation, at least in theory. In 1905 Einstein produced the special theory of relativity, and it was found that physics is really a four-dimensional affair. Consequently the curls in the Maxwell equations could no longer pretend to be vectors. When the familiar Maxwell equations were rewritten in the new four-dimensional notation they took the following very compact form:

$$F_{ab} = \phi_{b,a} - \phi_{a,b}; \quad g^{ac}g^{bd}F_{ab,c} = j^d \tag{3.7}$$

Notice all the second-rank tensors, and even one of the third rank!

In 1915 Einstein perfected his general theory of relativity and proved thereby that the world—the four-dimensional world of physics—is curved. In a curved world there are no straight lines, and thus no Cartesian co-ordinates. The metrical tensor, and many others, could therefore no longer hide but were forced relentlessly into the full light of day.

Pure physics is not the only field in which tensors are useful. At the depth of the depression, when jobs were so hard to find, the tensor obtained work in electrical engineering. This was due mainly to the efforts of Kron, who developed an elaborate theory of rotating electric machinery making extensive use of tensor ideas. This theory puts tensors to three quite distinct uses. The theory of the connection matrix is hardly tensor analysis in the accepted sense, being rather an application of that abstract branch of mathematics called *analysis situs*. On the other hand, Kron's applications of the theory of symmetrical components and allied topics makes much use of tensors in a "space" whose "co-ordinates" are alternating currents of different phases. In this part of the theory a generalized form of tensor called a *spinor* plays an important part. Finally, Kron's theory of the general electric machine—no advertisement intended—not only incorporates the two previous ideas but also brings in tensors belonging to a so-called "cylindrical space" some of whose co-ordinates are geometrical while the others are electrical. In studying Kron's work it is essential to distinguish the different types of tensor employed.

In a discussion of the uses of tensors it would be an omission of the first magnitude not to mention geometry. Think of all the objective entities treated therein through co-ordinates; straight lines and curves, planes, quadric surfaces, curvature, torsion, and a thousand others. All these require tensors. A quadric surface, for instance, is represented with the help of a second-rank covariant tensor. That is why we talk in mechanics of a *momental ellipsoid*, a *stress quadric*, and the like.

In closing this whole discussion of tensors, it is fitting that we mention a few details concerning that celebrated tensor the *curvature tensor;* a tensor which, in one way or another, touches every aspect of tensor analysis.

The curvature tensor measures the curvature of a space. There is a definite difference between, for instance, a flat and a curved surface, as is evident from mere inspection. It is not so evident, though, that the curvature of a surface can be determined from measurements made in the surface itself, without going outside to have a look at it. On a plane the three angles of a triangle always add up to two right angles. On a curved surface they do not, except by accident. Imagine a globe of the earth, with pole P and equator AB, as in figure 6. In the spherical triangle PAB the angles A and B are each right angles, while angle P can vary over a wide range. Thus the sum of the angles of a spherical triangle is not two right angles but depends on the triangle. We can measure angles without leaving the surface. Therefore we can detect the curvature without leaving the surface. Measurement of angles, as of lengths, depends on the metrical tensor g_{ab}. The curvature of a surface, or of a space of any number of dimensions, thus leaves its effect on g_{ab}. The puzzle is to distill g_{ab} so as to evaporate everything except these curvature effects. The distillate has been discovered. It is the curvature tensor

$$R^a_{bcd} = -\frac{\partial\left\{ {a \atop bc} \right\}}{\partial x^d} + \frac{\partial\left\{ {a \atop bd} \right\}}{\partial x^c} - \left\{ {e \atop bc} \right\} \left\{ {a \atop ed} \right\} + \left\{ {e \atop bd} \right\} \left\{ {a \atop ec} \right\} \tag{3.8}$$

This mighty tensor was first discovered by Riemann, and lest we be tempted to regard it as a purely geometrical tensor, let it be mentioned that Riemann discovered it in thinking about a problem in heat conduction forming the subject of a prize competition of the Paris Academy. Incidentally, Riemann's paper did not get the prize!

This curvature tensor, which began as a tensor in the theory of heat, soon became a key tensor in geometry. It was later used by Einstein in his gravitational equations supplanting those of Newton, and is also used by Kron in his theory of rotating electrical machines. R^a_{bcd} is as ubiquitous as g_{ab} since as soon as g_{ab} exists it brings R^a_{bcd} into existence as an automatic and important consequence.

All the time, R^a_{bcd} has been lurking in equation 1.1, with its components zero and thus quite invisible. Mere tugging at the co-ordinates disturbed it not at all; it is far too old a hand to be caught as easily as that. Nothing short of an earthquake will make it appear. The plane itself must first be rudely distorted into an uneven surface before old R^a_{bcd} will begin to show itself. So long as there is no curvature it remains zero, but even when zero it still exists and as a whole tensor field, at that!

What a wonderful hunting ground equation 1.1 has turned out to be. We have been able to extract tensor after tensor from this apparently empty formula, as if we were magicians pulling rabbits out of a hat. Would you like to know the secret of the trick? It is really very simple. With a little patience anyone can find rabbits in a field!

Journals for Electrical Engineers

By CHARLES F. DALZIEL
ASSOCIATE AIEE

MOST ENGINEERS as well as educational and research institutions are continually faced with the problem of locating reliable, adequate, and up-to-date sources of information. Obviously, standard textbooks and important periodicals are the basic sources. However, because textbooks present in permanent form generally accepted theories or facts which probably first appeared in periodical publications at a much earlier date, the latter are the most important sources of current information. This article is an abridgement of a recent report on evaluation of scientific periodicals,[1] and pre-

Written especially for ELECTRICAL ENGINEERING, based on "Evaluation of Periodicals for Electrical Engineers," *The Library Quarterly*, Unviersity of Chicago Press, July 1937, from which tables I to IV are republished.

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1. For all numbered references, see list at end of paper.

Table I. Total References to Foreign Journals

Periodical	Number of Issues per Year	Académie des Sciences, Comptes rendus	Elektrotechnische Zeitschrift	Archiv für Elektrotechnik	Revue général de l'électricité	Physikalische Zeitschrift	Zeitschrift für Physik	Hochfrequenztechnik und Elektroakustik	Annalen der Physik	Zeitschrift des Vereines deutscher Ingenieure	English References to Foreign Magazines	Total References to Foreign Magazines
1. *Annalen der Physik* (German)	24	63	22	21	12	199	302	14	(404)	3	349	985
2. *Zeitschrift für Physik* (German)	*	55	33	26	19	312	(983)	9	238	3	280	975
3. *Physikalische Zeitschrift* (German)	24	21	23	10	20	(236)	177	15	100	2	152	520
4. *Archiv für Elektrotechnik* (German)	12	27	159	(180)	1	13	49	16	12	2	77	356
5. *Zeitschrift für physikalische Chemie* (German) {(Abteilungen A) (Abteilungen B)}	*	71	2		1	95	49	1	61		41	321
6. *Zeitschrift für technische Physik* (German)	12		48	32	11	42	43	23	21	28	60	308
7. *Naturwissenschaften* (German)	52	9	4	5	11	88	76	5	22		76	296
8. Académie des Sciences, *Comptes rendus*	52	(1,333)	1	1	91	12	47	9	13	2	96	262
9. *Proceedings of the Koninklijke Akademie van Wetenschappen te Amsterdam* (Dutch)	*	38	92	19							39	188
10. *Elektrische Nachrichten Technik* (German)	12		36	7		17	2	58	11		42	173
11. *Elektrotechnische Zeitschrift* (German)	52		(759)	57	18	5	8	14	2	42	19	165
12. *Hochfrequenztechnik und Elektroakustik* (German)	12		17	4	1	26	2	(66)	16	5	90	161
13. *Elektrotechnik und Maschinenbau* (German)	52		76	23	7	4	2	1		3	26	142
14. *Journal de physique et le radium* (French)	12	52	2		2	17	29	1	9		23	135
15. *Zeitschrift für anorganische und allgemeine Chemie* (German)	*	46	4			6	12		24		26	118
16. *Deutsche Gesellschaft für chemisches Apparatewesen* (German)	24	105	2									107
17. *Elektrizitätswirtschaft Mitteilungen* (German)	24		35	2	4					30	1	72
18. *Journal de chimie physique* (French)	10	27				14	3		4		19	67
19. *Wissenschaftliche Veroffentlichungen aus dem Siemens Konzern* (German)	*	5	12	13		2	4	3	6	4	16	65
20. *Siemens Zeitschrift* (German)	12		32	10	4	1	1	7		4	1	60
21. *Annales de chimie* (French)	12	58				1					1	60
22. *Helvetica physica acta* (French)	*			6		8	25		8		12	59
23. *Zeitschrift des Vereines deutscher Ingenieure* (German)	52		42	2	1	3	4		3	(750)	2	57
24. *Zeitschrift für Elektrochemie und angewandte physikalische Chemie* (German)	12	5		3	2	3	27		7		10	57
25. *Schweizerische elektrotechnischer Verein* (German)	24		25			4				16		45
26. *Physica* (Dutch)	10			1		24			1		14	40
27. *Zeitschrift für Instrumentenkunde* (German)	12		22	2	1			1	6	1	7	40
28. *Zeitschrift für Kristallographie* (German)	12					7	14				14	35
29. Société Française Electriciens, *Bulletin* (French)	12				32						2	34
30. *Archiv für Technisches Messen* (German)	12		11	20		1					1	33
31. *Allgemeine Elektricitäts Gesellschaft, Mitteilungen* (German)	12		16	4		2		3		7		32
32. *Revue genéral de l'electricité* (French)	52		8	3	(472)		2			2	12	27
33. *Kolloid Zeitschrift* (German)	12	16	4								7	27
34. *Telefunken-zeitung* (German)	4		3			4		10			9	26
35. *L'Elettrotecnica* (Italian)	24		5		13			4			3	25
36. *Deutsche Beleuchtungstechnische Gesellschaft* (German)	24		18		2	1			1		1	23
37. *Mathematische Zeitschrift* (German)	5	21		1								22
38. *Atti della Reale Accademia Nazionale dei Lincei* (Italian)	*	9	1	4					2		2	18
39. *Mathematische Annalen* (German)	*	13		2					1		1	17
40. *Sitzungsberichte der Preussischen Akademie der Wissenschaften Mathematischnaturwissenschaftlichte Klasse* (German)	*	16									1	17
41. *L'Onde électrique* (French)	12	2									14	16
42. *Alta frequenza* (Italian)	6		3					5	1		5	14
43. *Telegraphen und Fernsprechtechnik* (German)	12		1	2					1		10	14
44. *Stahl und Eisen* (German)	52		6			4					4	14
45. *Zeitschrift für angewandte Mathematik und Mechanik* (German)	6					4				3	4	11
46. *Revue d'optique théorique et instrumentale* (French)		7									2	9
47. *Annales des postes, télégraphes et téléphones* (French)	12										8	8
48. Kamerlingh Onnes Laboratorium der Rijks-Universiteit te Leiden, *Communications* (Dutch)											7	

* Published at irregular intervals.

Table II. References to Foreign Journals Found in English-Language Journals

Periodical	Proceedings of the Physical Society	London, Edinburgh and Dublin Philosophical Magazine and Journal of Science	Journal of the Institution of Electrical Engineers	Electric Journal	Electronics	Electrical Engineering	Journal of the Franklin Institute	General Electric Review	Bell System Technical Journal	Proceedings of the Institute of Radio Engineers	Physical Review	Total English References to Foreign Magazines
1. *Annalen der Physik*	37	84	15		2	15	5		3	18	170	349
2. *Zeitschrift für Physik*	1	112	16	2	3	34	12	1	16	15	68	280
3. *Physikalische Zeitschrift*	11	28			13	14	6		6	7	67	152
4. Académie des Sciences, *Comptes rendus*	9	32	3			2	3		2	17	28	96
5. *Hochfrequenztechnik und Elektroakustik*	6	1	40	1	21	4	2		1	10	4	90
6. *Archiv für Elektrotechnik*		3	17	3	1	36	3		1	10	3	77
7. *Naturwissenschaften*		16	4			4	1		7		44	76
8. *Zeitschrift für technische Physik*	2	9	13		4	5	2	3	2	19	1	60
9. *Elektrische Nachrichten Technik*	3		11		11	1				16		42
10. *Zeitschrift für physikalische Chemie*	9	15	1				2				14	41
11. Koninklijke Akademie van Wetenschappen te Amsterdam, *Proceedings*	22	2			4						11	39
12. *Elektrotechnik und Maschinenbau*			13			13						26
13. *Zeitschrift für anorganische und allgemeine Chemie*	22	4										26
14. *Journal de physique et le radium*	2	2				1					18	23
15. *Elektrotechnische Zeitschrift*					4	12		1		2		19
16. *Journal de chimie physique*	1	11	3		2						2	19
17. *Wissenschaftliche Veroffentlichungen aus dem Siemens Konzern*		2	8	2		5	1	1			2	16
18. *L'Onde électrique*	1				8					5		14
19. *Physica*	2	5			3		2			2		14
20. *Zeitschrift für Kristallographie*	1	8									5	14
21. *Helvetica physica acta*		2				2				3	5	12
22. *Revue général de l'électricité*			2		5	5						12
23. *Telegraphen und Fernsprechtechnik*			9		1							10
24. *Zeitschrift für Elektrochemie und angewandte physikalische Chemie*		10										10
25. *Telefunken-zeitung*					1					7	1	9
26. *Annales des postes, télégraphes et téléphones*			3							5		8
27. *Kolloid Zeitschrift*		7										7
28. Kamerlingh Onnes Laboratorium der Rijks-Universiteit te Leiden, *Communication*			7									7
29. *Zeitschrift für Instrumentenkunde*	2	1	1		1		1				1	7
30. *Alta frequenza*			2							3		5
31. *Stahl und Eisen*						4						4
32. *Zeitschrift für angewandte Mathematik und Mechanik*		4										4
33. *L'Elettrotecnica*			2								1	3
34. *Atti della Reale Accademia Nazionale dei Lincei*											2	2
35. *Zeitschrift des Vereines deutscher Ingenieure*	1					1						2
36. *Revue d'optique théorique et instrumentale*	1											1
37. *Deutsche Beleuchtungstechnische Gesellschaft*	1											1
38. *Archiv für Technisches Messen*				1								1
39. *Siemens Zeitschrift*						1						1
40. *Annales de chimie*	1											1
41. *Mathematische Annalen*						1						1
42. *Sitzungsberichte der Preussischen Akademie der Wissenschaften Mathematisch-naturwissenschaftlichte Klasse*					1							1
43. *Elektrizitätswirtschaft Mitteilungen*						1						1
44. Société Française Electriciens, *Bulletin*	1											1

sents lists totaling 108 journals for electrical engineers.

A list of all the engineering periodicals purchased by the General Library and the College of Engineering Library, University of California, together with McNeely and Crosno's 50 periodicals for electrical engineers,[2] was circulated among members of the department of electrical engineering for rating. This gave a preliminary list of important journals which were then used for a reference count involving 20,322 references. The results of the investigation are arranged in four tables. A list of 48 foreign journals, obtained from tabulating the references found in 9 foreign and 11 English-language periodicals is given in table I. A tabulation of foreign journals obtained from the references found in the 11 English-language periodicals is given in table II. A list of 60 English-language periodicals obtained from the references found in the 9 foreign and the 11 English-language magazines is given in table III. The list of English-language journals obtained from the foreign references is given in table IV. Tables II and III should be of particular interest to English-speaking institutions, while tables I and IV should be of value to those in foreign countries.

The following precautions were taken in this study: (1) In order to allow for radical differences in editorial policies, styles, and languages, periodicals published in foreign languages have been tabulated separately. (2) All references to the same publication as that in which the citation appears have been recorded but not counted in obtaining the totals. This was done to eliminate criticism regarding any undue advantages of the magazines used for reference counting. (3) In order to limit the references to fields associated with electrical engineering, the periodicals used for reference counting were the available publications selected from those receiving the highest faculty rating. (4) In order to limit further the references to this field, all periodicals on the final lists, that is, tables I and III (with a few exceptions) were referred to by two or more publications. (5) The journals used for reference counting were taken for the year 1934. Where certain issues were not available, the correspond-

Table III. Total References to English-Language Journals

Periodical	Number of Issues per Year	Proceedings of the Physical Society	London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science	Journal of the Institution of Electrical Engineers	Electric Journal	Electronics	Electrical Engineering	Journal of the Franklin Institute	General Electric Review	Bell System Technical Journal	Proceedings of the Institute of Radio Engineers	Physical Review	Foreign References to English-Language Magazines	Total References to English-Language Magazines
1. *Physical Review*	24	48	124	20	1	1	62	124	13	35	23	(1,340)	819	1,270
2. Royal Society of London {*Proceedings* / *Transactions*}	*	36	41	2		1	12	13		19	20	239	316	699
3. *London, Edinburgh and Dublin Philosophical Magazine and Journal of Science*	12	64	(16)	18		1	11	9	1	'6	30	119	223	482
4. *Nature*	52	12	40	8		1		7		5	30	82	159	344
5. *Electrical Engineering*	12	1	8	50	12		(459)	11	54	34	4		117	291
6. *Journal of the American Chemical Society*	12	5	26	3			2	30				53	153	272
7. *Proceedings of the Institute of Radio Engineers*	12	7	1	21		6	30	4	2	35	(180)	8	61	175
8. *Journal of the Institution of Electrical Engineers*	12	11	6	(148)	2	1	15		2		14	3	67	121
9. *General Electric Review*	12			5	1	1	51	3	(70)		1	9	49	120
10. *Electrical World*	24			7	7		28	2	9		1		55	109
11. *Journal of the Franklin Institute*	12	1	6	4	3		18	(47)	7	4	2	23	39	107
12. *Proceedings of the National Academy of Sciences*	12		2									49	54	105
13. *Transactions of the Optical Society*	12	9	8			1	3	3	2	1	1	33	41	102
14. *Review of Scientific Instruments*	12	2		2		8	4	7	4	3	1	47	22	100
15. *Bureau of Standards Journal of Research*	12		2	3				10		1	31	4	42	93
16. *Proceedings of the Physical Society*	6	(93)	5	12		2	1	2		2	20	9	36	89
17. *Astrophysical Journal*	10	5	2		1	8	10	2	1	2	1	34	19	85
18. *Bell System Technical Journal*	4	1	1	14	1		23	2	2	(59)	20		16	80
19. *Indian Journal of Physics*	*	2	4									10	47	63
20. *Reviews of Modern Physics*	4	1	1							1		57	3	63
21. *Electrician*	52		2	14		2	5			1	3		35	62
22. *Journal of the Acoustical Society of America*	4	9		2			10		1	1	15		22	60
23. *Journal of Chemical Physics*	12	3	7	3		1	3	14	1			17	8	57
24. *Wireless Engineer and Experimental Wireless*	12	1				5	2				37		5	57
25. *Physics*	12	6		10	1	2	5	4	2	5	3	5	13	56
26. *Proceedings of the Cambridge Philosophical Society*	4	2	20	5			2	2				20		51
27. *Electric Journal*	12			4	(20)			24	6			1	14	49
28. *Transactions of the Faraday Society*	12	8	16				2	7					16	49
29. *Engineering*	52	1	3	4	1		3	2	3				30	47
30. *Journal of Scientific Instruments*	12	7	9	4				1	1		2	6	5	35
31. *Science*	52	1	1				2	5				9	10	28
32. *Post Office Electrical Engineers Journal*	4			19									3	22
33. *Mechanical Engineering*	12						1	4	8				8	21
34. *Electrical Communication*	4	2		12		1	1				1		1	18
35. *Railway Age*	52			1			3		1				13	18
36. *Proceedings of the American Academy of Arts and Sciences*	24	8					1					4	4	17
37. *Society of Motion Picture Engineers Journal*	12						2			4	2		9	17
38. *Electronics*	12					(23)	4	1			9		2	16
39. *Radio Engineering*	12					1		3		1	6		5	16
40. *Electrical Review*	52			6			2		1				6	15
41. *Engineering News Record*	52												14	14
42. *Journal of the Institute of Electrical Engineers of Japan*	12	1			1	1	1				6		3	13
43. *Transactions of the American Electrochemical Society*	2				1		6	1				2	2	12
44. *Engineer*	52		1	4			1	2					3	11
45. *Wireless World*	52			2							8		1	11
46. *Transactions of the Royal Society of Edinburgh*			3									8		11
47. *Journal of the Chemical Society*	12												10	10
48. *American Journal of Science*	12	1	2										5	8
49. *Bell Laboratories Record*	12			3			3						2	8
50. *American Mathematics Society Transactions*	6												8	8
51. *American Railway Engineering Association Bulletin*	10						3					3		6
52. *Transit Journal*	12						6							
53. *Edison Electric Institute Publications*	*						5	1						6
54. *Radio World*	52												6	6
55. *American Journal of Roentgenology and Radium Therapy*	12			2									3	5
56. *Transactions of the American Illuminating Engineering Society*	9						1	1	3					5
57. *Power*	12						4		1					5
58. *Instruments*	12		4											4
59. London Mathematical Society {*Journal* / *Proceedings*}	4 / 13*												4	4
60. *Power Plant Engineering*	12						1		1					2

* Published at irregular intervals.

ing issues of 1933 were used. Magazines no longer published were omitted, and the present title only is given in instances where it was known that mergers or changes in title have taken place.

The method used in this analysis is justified by the assumption that the most important technical contributions are based on previously published work; hence, periodicals containing valuable articles should contain some references to other important works. The tabulation of the references obtained from a representative number of periodicals covering the field should show relative values. Owing to different editorial policies, number of articles per issue, issues per year, and the type of article published, the results of any such tabulation must be interpreted with care. The actual location of any periodical in the lists is not an index of absolute

Table IV. Foreign References to English-Language Journals

Periodical	Academie des Sciences, Comptes rendus	Elektrotechnische Zeitschrift	Archiv für Elektrotechnik	Revue général de l'électricité	Physikalische Zeitschrift	Zeitschrift für Physik	Hochfrequenztechnik und Elektroakustik	Annalen der Physik	Zeitschrift des Vereines deutscher Ingenieure	Total Foreign References to English Magazines
1. *Physical Review*	45	21	4	32	353	266	10	88		819
2. Royal Society of London { *Proceedings* / *Transactions* }	18	7		3	91	151	8	30	2	310
3. *London, Edinburgh and Dublin Philosophical Magazine and Journal of Science*	13	1	6	12	71	72	13	33	2	223
4. *Nature*	27			104		4	11	13		159
5. *Journal of the American Chemical Society*	61	1			63	26		2		153
6. *Electrical Engineering*	2	74	15	19	2	2	2	1		117
7. *Journal of the Institution of Electrical Engineers*	12	26	4	17	1	1	8			67
8. *Proceedings of the Institute of Radio Engineers*		6	4	3	3		43	2		61
9. *Electrical World*		44	2	9						55
10. *Proceedings of the National Academy of Sciences*	10			2	19	20		3		54
11. *General Electric Review*	1	40		5	2			1		49
12. *Indian Journal of Physics*	14	20			4	8			1	47
13. *Bureau of Standards Journal of Research*	4	4		9		4	7	14		42
14. *Transactions of the Optical Society*	5			2	11	9		14		41
15. *Journal of the Franklin Institute*	1	6	2	1	15	2	4	8		39
16. *Proceedings of the Physical Society*	4	1	2	3	4	12	6	3	1	36
17. *Electrician*		25	2	3		2	2		1	35
18. *Engineering*		15							15	30
19. *Review of Scientific Instruments*	1	4		11	3	2		1		22
20. *Journal of the Acoustical Society of America*		8					6	8		22
21. *Astrophysical Journal*					1	8	10			19
22. *Bell System Technical Journal*		5	1	3		5	2			16
23. *Transactions of the Faraday Society*	2				5	9				16
24. *Electric Journal*		8	2	4						14
25. *Engineering News Record*									14	14
26. *Physics*		6			4	2		1		13
27. *Railway Age*		12							1	13
28. *Journal of the Chemical Society*	8				2					10
29. *Science*	3				3	3		1		10
30. *Society of Motion Pictures Engineers Journal*							9			9
31. *American Mathematics Society Transactions*	8									8
32. *Journal of Chemical Physics*	2				1	3		2		8
33. *Mechanical Engineering*			1						7	8
34. *Electrical Review*		4		2						6
35. *Radio World*							6			6
36. *Journal of Scientific Instruments*		2		2		1				5
37. *American Journal of Science*	5									5
38. *Radio Engineering*							5			5
39. *Wireless Engineer and Experimental Wireless*							5			5
40. *Proceedings of the American Academy of Arts and Sciences*					3			1		4
41. London Mathematical Society { *Journal* / *Proceedings* }	1		3							4
42. *American Journal of Roentgenology and Radium Therapy*	1							2		3
43. *Engineer*				1					2	3
44. *Journal of the Institute of Electrical Engineers of Japan*							3			3
45. *Post Office Electrical Engineers Journal*	3									3
46. *Reviews of Modern Physics*	3									3
47. *Transactions of the American Electrochemical Society*						2				2
48. *Bell Laboratories Record*		2								2
49. *Electronics*							2			2
50. *Electrical Communication*			1							1
51. *Wireless World*							1			1

value; the relative location, however, should aid in determining the importance of technical publications.

Those preparing for graduate work and research may be interested to note the languages of importance to electrical engineers. The usual academic requirement of French and German is amply justified from inspection of table II.

Examination of the lists may be disappointing to the adherents of a particular journal. It should be repeated that these lists are submitted as suggestions, only, and are subject to the limitations previously mentioned. The reader is referred to reference 1 for a more detailed discussion of assumptions, methods of analysis, and other points. The final choice of a particular magazine must be made after a detailed consideration of the needs of the individual or institution. Neglecting all other factors, the number of issues per year is an index of value; this information is included in tables I and III. The lists may be seen to be practically independent of the source of references. This is interpreted to mean that a sufficient number of references have been tabulated to obtain approximately full coverage of the field. This paper, which presents a much larger list than that previously published,[2,3] may assist those interested in a comprehensive list of technical periodicals for electrical engineers.

References

1. EVALUATION OF PERIODICALS FOR ELECTRICAL ENGINEERS, Charles F. Dalziel. *Library Quarterly*, University of Chicago Press, volume 7, number 3, July 1937, pages 354–72.

2. PERIODICALS FOR ELECTRICAL ENGINEERS, J. K. McNeely and C. D. Crosno. *Science*, volume 72, 1930, pages 81–4.

3. A STUDY OF SCIENTIFIC PERIODICALS, R. H. Hooker. *Review of Scientific Instruments*, volume 6, 1935, pages 333–8

News

Of Institute and Related Activities

AIEE 1938 Winter Convention Best Attended Since 1931

WITH a total registration of 1,438 members and their families and guests, attendance at the Institute's 1938 winter convention held in New York, N. Y., January 24–28, was the best since 1931 when a total of 1,589 registered. New attendance records were set for both the smoker and the dinner-dance, 1,201 for the former and 651 for the latter. Details concerning registration and attendance at technical sessions and other features of the program are given in accompanying tabulations.

Technical sessions began Monday morning, January 24, without the usual formal perfunctory opening session. As scheduled 16 technical sessions and 5 technical conferences were held. Other features included presentation of the 1937 Edison Medal to Past President Gano Dunn, presentation of the 1937 Alfred Noble prize to G. M. L. Sommerman (A'31, M'37), an address "Technological Development in Relation to Economics" by H. G. Moulton, and an address "New York World's Fair, 1939" by Stephen F. Voorhees. Nine members and guests took the post-convention trip to Bermuda. Details of these and other features of the convention are given on this and the following pages.

Registration for Inspection Trips

Trip	Registration
Motion pictures over coaxial cable—Bell Telephone Laboratories, Inc.	240
RCA television studio—National Broadcasting Co.	150
Sponsored broadcast, Consolidated Edison Co. of New York, Inc., "New York on Parade," NBC Studios	100
Okonite-Callendar Cable Co., Paterson, N. J.	78
New York Stock Exchange	76
S.S. "Monarch of Bermuda"	56
Waterside generating station—topping turbine—metal-clad bus	55
RCA Manufacturing Co., Inc., Harrison, N. J.	49
Radio City NBC studio tour, and Hall of Motion, New York Museum of Science and Industry	44
Westinghouse Electric & Manufacturing Co., meter works, Newark, N. J.	31
Sixth Avenue subway construction	27
Reading streamlined train, Jersey City, N. J.	25
Photoengraving plant—Powers Reproduction Corp	19
New York Fire College—City of New York	15
Hayden Planetarium	14
General Motors Corp., Linden (N. J.) Branch	10
Grid-controlled rectifier—Third Avenue Railway System	9
Wards Island sewage treatment plant—City of New York	8
Lincoln Tunnel—all-service bus—Newark Airport	6
Total	1,012

Lecture on 1939 World's Fair

Following the presentation of the Edison Medal to Gano Dunn on Wednesday evening, January 26, a lecture "New York World's Fair, 1939," was given by Stephen F. Voorhees, senior partner of Voorhees Gmelin and Walker. Mr. Voorhees described the plan of the fair, which will be held in Queens County, New York City, and which is scheduled to open April 30, 1939. This date marks the 150th anniversary of the inauguration, in New York City, of George Washington as first president of the United States. Mr. Voorhees described some of the buildings that have been planned and outlined the progress of construction to date. His lecture was profusely illustrated with both black-and-white and colored slides.

Inspection Trips

A total of 1,012 members and guests, or 70 per cent of the total number registered, attended the 19 scheduled events on the inspection-trips program. Details of attendance are shown in an accompanying tabulation. Three events were complete "sell-outs," in other words, all available tickets were disposed of; these were the radiobroadcast on Monday evening, and the television inspection trips to the National Broadcasting Company studios, and the Bell Telephone Laboratories held on Friday. Inclement weather restricted the number taking the bus trips to the General Motors plant and to Newark Airport.

E. R. Thomas was chairman of the inspection trips committee; other members were: W. E. Appleton, C. L. Chatham, G. F. Fowler, Henry Kurz, H. G. Life, W. J. Quinn, H. B. Stoddard, G B. Teevan, and R. H. Twiss.

Smoker and Dinner-Dance

As usual in recent years, the smoker, which was held in the Commodore Hotel, attracted the largest attendance of any event on the convention program. The attendance, 1,201, eclipsed even last year's figure, which was considered to be a record for this event. After the dinner, there was an excellent stage show comprising a variety of entertainment by accomplished performers. The smoker committee consisted of E. S. Banghart, chairman, W. H. Farlinger, P. G. Fredericks, W. Jordan, J. Eliot McCormack, J. H. Moore, E. G. D. Paterson, R. E. Powers, T. D. Relmers, B. J. Rowan, T. O. Rudd, D. W. Taylor, E. F. Thrall, and F. Van Olinda.

Social high light of the convention as usual, the dinner-dance this year was held at the Plaza Hotel. Following the custom established several years ago, the dance was followed by a buffet supper. Attendance,

Attendance at Technical Sessions and Conferences

Time		Attendance
Technical Sessions		
Monday		
10:00 a.m.	Communication	150
10:00 a.m.	Symposium on modern electric vehicles	130
2:00 p.m.	Symposium on a new carrier telephone system for toll cable	255
2:00 p.m.	Symposium on modern electric vehicles	150
Tuesday		
9:30 a.m.	Lightning protection	260
9:30 a.m.	Symposium on electronics—I	130
2:00 p.m.	Relays and reactors	248
2:00 p.m.	Symposium on electronics—II	75
Wednesday		
10:00 a.m.	General session	450
2:00 p.m.	Instruments and measurements	148
2:00 p.m.	Electric welding	65
2:00 p.m.	Basic sciences	70
Thursday		
9:30 a.m.	Power transmission	230
9:30 a.m.	Electrical machinery—I	50
2:00 p.m.	Television	250
2:00 p.m.	Cables and research	240
2:00 p.m.	Electrical machinery—II	75
Technical Conferences		
Monday		
2:00 p.m.	Radiation fields	75
Tuesday		
9:30 a.m.	Education	40
2:00 p.m.	Sound and vibration measurement	155
Thursday		
9:30 a.m.	Network analysis and synthesis	95
9:30 a.m.	Definitions	15
Total registered convention attendance		1,438

Analysis of Registration at 1938 Winter Convention

Classification	Dist. 3	Dist. 1	Dist. 2	Dist. 4	Dist. 5	Dist. 6	Dist. 7	Dist. 8	Dist. 9	Dist. 10	Totals
Members	686	222	247	8	67	2	16	3	2	13	1,266
Men guests	30	14	29	2	6		2				83
Women guests	51	16	16	1	1			2	1	1	89
Totals	767	252	292	11	74	2	18	5	3	14	1,438

which totalled 651, was the greatest in many years, and is believed to have set a new record. Of these, 298 attended the dinner dance, 159 the dance-buffet supper, and 194 both. The dinner-dance committee was headed by C. M. Gilt; he was assisted by F. L. Aime, T. S. Bacon, Tomlinson Fort, S. B. Graham, E. I. Green, F. G. Guldi, J. L. Holton, Thomas Maxwell, J. H. Pilkington, and S. A. Warner.

Womens Activities

While their husbands were attending the technical sessions and other weighty events of the convention, the women were enjoying the excellent program of entertainment arranged by energetic Chairman Mrs. George Sutherland and her committee. Most popular event proved to be the reception, luncheon, and bridge held Wednesday afternoon, January 26, at the Hotel Commodore. This was attended by more than 100. The tour to the Jules Bache home was a "sell-out," attendance being limited to 24. Approximately 100 women took the tour to see the Jensen handmade silver exhibit on Tuesday afternoon, January 25; this was followed by a reception and tea at the British Empire Exhibition Room, Radio City, and later by a backstage tour of the Radio City Music Hall, after which the group attended the evening performance at that theater.

Assisting Mrs. Sutherland on the women's committee were: Mrs. E. S. Banghart, Mrs. T. F. Barton, Mrs. C. R. Beardsley, Mrs. O. B. Blackwell, Mrs. H. C. Dean, Mrs. A. F. Dixon, Mrs. C. M. Gilt, Mrs. F. M. Farmer, Mrs. Tomlinson Fort, Mrs. G. S. Rose, and Mrs. W. R. Smith.

Directors and Committees Meet

The AIEE board of directors met during convention week, as usual. The national nominating committee also met, in accordance with the Institute's by-laws, to select nominees for election to Institute officers for the year 1938–39. Reports of both these meetings are given in succeeding pages.

Meetings of the following Institute committees were held during winter convention week: automatic stations, basic sciences, communication, co-ordination of Institute activities, electric welding, membership, power generation, production and application of light, protective devices, research, safety, Sections, and technical program. In addition, meetings were held by the subcommittee on wave form, subcommittee on revision of AIEE Standard No. 4, lightning-arrester subcommittee, sectional committee on metal-tank mercury-arc rectifiers, subcommittee 1, sectional committee on electrical definitions, and the subcommittee on the study of test codes. A luncheon for Student Branch counselors, followed by informal discussion, was held under the auspices of the committee on Student Branches, following the custom established several years ago. Brief reports of most of these meetings are given in succeeding pages.

Winter Convention Committee

The committee responsible for the success of this year's convention was headed by T. F. Barton; assisting him were: C. R. Beardsley, O. B. Blackwell, G. E. Dean, A. F. Dixon, E. E. Dorting, H. S. Osborne, C. S. Purnell, George Sutherland, and F. P. West.

Attendance at Special Features of Recent Winter Conventions

Feature	1936	1937	1938
Total registration	1,231	1,165	1,438
Smoker	1,025	1,175	1,201
Dinner dance	486	500*	651
Inspection trips	1,753	926	1,012

* Estimated.

Analysis of Registration at Recent Winter Conventions

District	1935	1936	1937	1938
New York City and foreign (3)	694	697	629	767
Middle Eastern (2)	153	222	216	292
North Eastern (1)	194	219	222	252
Great Lakes (5)	38	43	38	74
South West (7)	5	11	12	18
Canada (10)	21	11	17	14
Southern (4)	6	15	21	11
Pacific (8)	1	4	7	5
North West (9)	1	3	1	3
North Central (6)	1	6	2	2
Totals	1,114	1,231	1,165	1,438

North Eastern District to Meet at Lenox, Mass.

A three-day meeting and Student Branch convention of the AIEE North Eastern District will be held May 18–20, 1938, at Lenox, Mass., under sponsorship of the Pittsfield Section. Headquarters will be at the Curtis Hotel, and arrangements have been made to house those attending in this hotel and in other hotels in town. K. B. McEachron (A'14, M'20, director) past-chairman of that Section is general chairman of the committee on arrangements.

Lenox, reputedly one of the most beautiful villages in New England, is situated about six miles from Pittsfield in the heart of the Berkshire Mountains, and provides a meeting place that is considered second to none in this section of the United States. Every type of natural beauty is available. In the township of Lenox are some of the most extensive estates in the East, including what was formerly "Shadowbrook," Andrew Carnegie's magnificent home

Among those present at the winter convention

Top, left to right: C. S. Rich, secretary, and H. S. Osborne, chairman, technical program committee, New York, N. Y.; Director C. A. Powel, East Pittsburgh, Pa.; Vice-President I. Melville Stein, Philadelphia, Pa.; and Vice-President C. E. Rogers, Seattle, Wash.

Bottom, left to right: C. T. Sinclair, past chairman, committee on power transmission and distribution, Pittsburgh, Pa.; Chairman J. A. French of the Connecticut Section; H. P. Seelye, past chairman, Detroit-Ann Arbor Section; Col. Azel Ames, New York; Vice-President A. C. Stevens, Schenectady, N. Y.; and Vladimir Karapetoff, past chairman of committees on education and electrophysics, Ithaca, N. Y. (photo by C. B. Oler, New York)

now used as a Jesuit novitiate. Lenox also is within easy reach of Mt. Greylock, highest peak in Massachusetts; the Mohawk Trail, a scenic highway originally traced by Indians; Monument Mountain; Taconic Trail; and many lakes, streams, and waterfalls.

An attractive program of entertainment, sports, trips, and technical sessions will be offered. According to present plans there will be three technical sessions at which papers of interest to groups of engineers in the District will be presented, and a general session at which one or more addresses of interest to the entire attendance will be arranged. The first technical session will deal with the problems of voltage control in relation to power-system planning and operation with special attention to voltage regulation of rural lines. The second session will treat industrial applications in the textile and paper mills, the stopping of induction motors, and capacitor applications in industry. Another session is comprised of a group of selected subjects which are not on particularly related subjects, but some of the papers discuss lightning problems. It is expected that the student session, at which papers will be presented by the students, will be held Friday, May 20. On that evening a student dinner and dance, which is an innovation, will be held under the auspices of the Stanley Club in Pittsfield.

The committee has made arrangements for attractive hotel rates during the meeting which range from $7.75 to $5.00 per day, American plan, with special rates for students as low as $4.50 per day. Coupon books covering room, meals, entertainment, and trips will be issued at the time of registration. In the event that anyone wishes to omit part of the program a refund schedule has been arranged for that purpose.

Convention General Session Evokes Wide Interest

Marking an innovation in winter-convention programs, the "general" session held the morning of January 26 aroused wide interest, as was evidenced by the 450 members and guests who attended. The principal feature of the session was an address "Technological Development in Relation to Economics," delivered by H. G. Moulton, president of the Brookings Institution, Washington, D. C., and eminent economist. The great interest in this address was further evidenced by the many questions asked at its conclusion, which Doctor Moulton had previously agreed to answer, and the wide publicity given it by the press. An article embracing the essential substance of the address was published in the February issue, pages 51–6. Preceding Doctor Moulton on the program were brief addresses by President W. H. Harrison and T. F. Barton, chairman of the winter convention committee, and the presentation of the 1937 Alfred Noble prize to G. M. L. Sommerman (A'31, M'37) research engineer of the American Steel and Wire Company, Worcester, Mass.

In opening the meeting, President Harrison, who presided throughout the session, extended the official welcome to those attending the convention, then spoke briefly as follows:

President Harrison's Address

"In opening this meeting, I am happy to be able to say that, in spite of what is commonly spoken of as the "recession" in business quarters, progress in connection with the activities of the Institute is being made in almost every direction. For example, since our last convention the number of applications for membership is slightly greater than the corresponding figure for the previous year. For eight months, May 1 to December 31: 1936—561; 1937—576.

"Many of you have in mind that with a view to carrying on the activities of the Institute at the highest possible level, the budget adopted by the board of directors for the appropriation year beginning October 1, 1937 was figured on a very close basis with estimated expenses equal to estimated revenues. You will be glad to know that at the present time with four months of the appropriation year gone, the optimism which characterized that budget seems to have been justified. Income so far is at a rate slightly higher than that estimated and expenses are at a rate about one per cent lower than provided for in the budget.

"Section activities are continuing at a very high rate and there is some indication that they may exceed the mark set last year, which is higher than any previous year (621 Section and group meetings). Aside from the high honor of the office and the privilege to be of service to the Institute, perhaps the greatest pleasure that I have gotten from being president is the opportunity afforded me to visit the various Sections. Of course, I cannot visit all and regret this greatly. To see the constructive work done in the Sections on behalf of the Institute membership, and to see the grand interest taken in the affairs of the Institute is a great inspiration."

H. G. Moulton delivering his address "Technological Development in Relation to Economics"

President Harrison then introduced T. F. Barton, chairman of the winter convention committee who spoke briefly concerning the convention program, calling specific attention to the special and entertainment features, and the inspection trips.

Noble Prize Presented

Following Mr. Barton's remarks, President Harrison introduced Doctor Robert Ridgway, chairman of the Alfred Noble prize committee, and past-president and honorary member of the American Society of Civil Engineers. Doctor Ridgway outlined briefly the history of the Noble prize and the conditions governing its award (*EE, Dec. '37, p. 1519*).

"One of the happy spots in the garden of my memories," said Dr. Ridgway, "is my association with Alfred Noble, a grand, simple, and noble character, who inspired confidence, respect, and affection of those who knew him. He was not only a good engineer, but a good citizen. If the bestowal of the prize which was named in his honor carries with it some of the inspiration of his mind and character, the recipient is indeed doubly fortunate."

At the conclusion of his remarks, Doctor Ridgway presented the prize to Doctor Sommerman, congratulating both him and the AIEE, "because this is the third time the prize has come to a member of this Institute since 1931, the year of the first award."

Petersen Coils Discussed at Lightning Session

Five papers were presented at the session on lightning protection, over which K. B. McEachron, vice-chairman of the protective devices committee, presided. Two of the papers discussed the Petersen coil, which is a device used to tune a transmission system in order to aid extinction of arc following flashover. Although many installations have been made in Europe, only a few have been made in the United States.

The first paper presented at this session was "Characteristics of the New Station-Type Autovalve Lightning Arrester," by W. G. Roman (A'29) of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. (*EE, July '37, p. 819–22*). In this arrester, inserts of silicon carbide are used in the gap. Discussion indicated that opinion as to their value is divided. Tests on the material were reported to have given erratic results. K. B. McEachron recommended the use of overhead ground wires extending 2,000 feet from the station, in order to put a definite duty on the lightning arrester.

Further data on lightning were presented in the paper "Discharge Currents in Distribution Arresters—II," by K. B. McEachron (A'14, M'20) and W. A. McMorris (A'30) of the General Electric Company, Pittsfield, Mass. In 1,608 records, 12 exceeded 25,000 amperes. Of the total number, 1,011 were negative and 597 were positive. The smaller ratio of negative to positive discharges compared to measurements on transmission line towers is thought to be due to the lower height of the distribution circuits. In general, the largest number of arrester and transformer failures and fuses blown were found to occur with relatively small currents of 3,000 amperes and less, perhaps because of the greater preponderance of currents of this magnitude. I. W. Gross (A'12) of the American Gas and Electric Service Corporation, New York, pointed out that although the AIEE Standards for equipment are based on lightning currents much lower than those now being measured, lightning arresters have operated with apparent satisfaction.

A collection of data from many operating companies was presented in the paper by L. G. Smith (A'22, F'34) Consolidated Gas Electric Light and Power Company of Baltimore, entitled "Distribution Trans

former Lightning Protection Practice—II." Insofar as the rate of primary fuse blowing is concerned, it was shown that solid interconnection of primary and secondary neutrals with tie to the transformer case, seems to be the best, followed by the more conventional solid interconnection and the common primary and secondary neutral schemes. Following in order were the surge-proof transformer, the three-point connection, the standard connection, and the gapped interconnection. It was also concluded that solid interconnection does not seem to increase the number of meters burned out or troubles on the customers premises. There are inconsistencies in the data for transformer windings, but failures apparently are not increased. Arrester failures are at a minimum with the solid interconnection. The most important single factor was said to be the ground resistance, and a lack of consideration throughout the industry in maintaining a low ground resistance was pointed out. J. R. North (A'21, M'29) Commonwealth and Southern Corporation, Jackson, Mich., urged uniformity of terminology for transformer connections.

Improvement in service by the tuned-reactance method of grounding a system neutral was discussed in the paper "Some Engineering Features of Petersen Coils and Their Application," by E. M. Hunter (A'28, M'36) of the General Electric Company, Schenectady, N. Y., which was published in the TRANSACTIONS section of the January issue, pages 11–18. The Petersen coil eliminates the transient overvoltages of the isolated-neutral system and the short circuits of the grounded-neutral system by extinguishing automatically the arc at the point of fault. The coils are connected between system neutral and ground and tuned to compensate for the changing current of the line. Ground faults from transient causes then can be quenched without deenergizing the circuit.

The second paper on Petersen coils was "Test and Operation of Petersen Coil on 100-Kv System of Public Service Company of Colorado," by W. D. Hardaway (A'22, M'32) Public Service Company of Colorado, Denver, and W. W. Lewis, (A'09, M'13) General Electric Company, Schenectady. The line described traverses mountainous country and is exposed to lightning. Overhead ground wires and expulsion protective gaps were limited in application by the design of the existing towers, and the coil was installed as a possible solution to the problem of improving service. Following a period of initial adjustment, in four months the coil operated successfully to extinguish all single-phase-to-ground flashovers, with one exception, and to extinguish 72 per cent of all flashovers. Motion pictures, some in color, were shown of staged tests on the extinguishing of arcs by the use of Petersen coils.

Considerable discussion of the last two papers was presented. H. P. Sleeper (A'22, M'30) Public Service Electric and Gas Company, Newark, N. J., expressed the belief that the time is coming when fault relief by means of devices, known or at present unknown, that will maintain operation of the system will be used instead of disconnection. Some allowance must be made for unknown factors on the line, such as the nearness of trees, in tuning the coil; this allowance was said to be greatest for low-voltage systems. Herman Halperin (A'21, M'26) of the commonwealth Edison Company, Chicago, Ill., did not see that Petersen coils would be of value on a cable system; however, although cable faults are generally permanent, the use of the coil may permit operation until a more convenient time for removal of the cable from service. R. E. Hellmund (A'05, F'13) Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., volunteered some observations that he had made of experience with Petersen coils in Europe. He urged careful consideration and cautious proceeding.

Future AIEE Meetings

North Eastern District Meeting
Lenox, Mass. (Pittsfield Section)
May 18–20, 1938

Summer Convention
Washington, D. C., June 20–24, 1938

Pacific Coast Convention
Portland, Ore., August 9–12, 1938

Southern District Meeting
Miami, Fla., November 1938

Sessions on Communication Include Television

Three convention sessions were devoted to communication. At the first, which was presided over, as were the others, by W. L. Everitt, chairman of the AIEE committee on communication, papers were presented on coupling between parallel earth-return circuits, printing telegraph operation, electric remote-control accounting, and a single-channel carrier telephone system; a second session was devoted to a symposium on the new carrier telephone system for toll cables. Systems of television with which experiments are now being made with transmission by coaxial cable and by radio were described in two special addresses at a session devoted to the subject. Inspection trips were available for those desiring to see the current status of the field work.

An experimental study of the coupling between parallel earth-return circuits, such as a telephone line and an electric railway, under d-c transient conditions on the latter was described in a paper by K. E. Gould (A'36) of Bell Telephone Laboratories, Inc., New York, N. Y. (*EE, Sept. '37, pp. 1159–64*). The study was undertaken because voltages measured on such communication circuits diverged from values computed on the basis of uniform earth resistivity. Test locations were chosen to give a large range of earth resistivity and, in one instance, a nonuniform earth structure. Measurements also were made of a-c couplings, and transient voltages computed from these values showed satisfactory agreement with the measured voltages, indicating that in this method of computing transient voltages the effects of nonhomogeneities of the earth were taken into account where such effects were of importance. In the ensuing discussion, the resistivity measurements were described in more detail. Earth resistance was found to vary with frequency in a manner somewhat similar to that caused by skin effect in conductors.

Operation of telegraph printers on way wires was described by G. S. Vernam (A'19) of the Postal Telegraph-Cable Company, New York, N. Y. A "way wire" is a telegraph conductor having intermediate offices or "way stations" connected to it to increase the traffic load. Manual operation has been used on such wires, but the decreasing supply of operators and the possibility of connecting the offices of private customers to the line has made operation of printers desirable. The new equipment is said to be simple and reliable, to permit the calling of individual way stations, and to prevent one way station from recording messages intended for another.

The paper "A System of Electric Remote Control Accounting" (*EE Feb. '38, Trans. pp. 78–87*) was presented by L. F. Woodruff (M'33) of Massachusetts Institute of Technology, Cambridge. The system described is used in a department store to maintain records on punched cards, although other applications are possible. In operation, each item of merchandise carries a tag punched according to a suitable code. At the time of sale, the salesclerk inserts the tag, a celluloid identification token, and, if it is a cash sale, an identification token for the cashier in a transmitter which sends the coded information to a recorder in a central accounting office. The recorder punches a standard record card, and the transmitter stamps the date of sale on the merchandise tag, which then serves as the customer's receipt. Five seconds is required for the operation. The sales audit and inventory may be determined from the record card by tabulating machines. A somewhat different procedure is followed for a charge sale, in order to permit charge authorization.

Presentation of this paper brought several questions from discussers. Reliability seemed to be the chief concern; in reply, the author described some of the safeguards used, such as the use of a two-hole code so that the apparatus is inoperative if either one or three holes are indicated by the transmitter.

The last paper of the first session devoted to communication was "A New Single Channel Carrier Telephone System" by H. J. Fisher (A'38), M. L. Almquist (A'23, M'31), and R. H. Mills (A'33) of Bell Telephone Laboratories, which was published in the TRANSACTIONS section of the January 1938 issue of ELECTRICAL ENGINEERING, pages 25–33. Mr. Almquist presented the paper, which describes an improved system at lower cost than the single-channel system heretofore available. Copper oxide "varistors" are used in place of vacuum tubes for modulation and demodulation. The upper side band is used for one direction of transmission and the lower side band for the other direction. It was said that 35 of these systems ranging in length from 25 to 160 miles, are now in use. The varistors evoked some comment; it was said that their use saves power, equipment, and maintenance when compared to vacuum tubes. E. E. George (A'20, F'36) of the Tennessee Electric Power Company, Chattanooga, in a discussion read by the chairman of the session, described the satis-

factory use of the equipment on a line of his company.

Carrier System for Toll Cables

At the session devoted to a symposium on a new carrier telephone system for toll cables, H. A. Affel (A'18, M'23) of the Bell Telephone Laboratories, described broad-band wire transmission systems in an introductory address. The use of the term "broad band" is relative and depends on the type of wire circuit. The present plan of development, when completed will provide three types of systems; (1) carrier telephony in cable up to 60 kilocycles and useful in existing cables; (2) an open-wire carrier system providing 12 channels above the present three-channel system and having a top frequency of 140 kilocycles; and (3) a coaxial cable system using frequencies up to one or two megacycles and providing upwards of 200 channels. The use of carrier systems in the United States began in 1918, and was made possible by the development of the vacuum tube and filter circuits. As more channels are added and higher frequencies are used other problems involving transposition, noise, and attenuation must be solved.

The following four papers, all by authors affiliated with Bell Telephone Laboratories, were presented:

1. A Carrier Telephone System for Toll Cables, by C. W. Green (A'10, M'26) and E. I. Green (A'23, M'30).

2. Cable Carrier Telephone Terminals, by R. W. Chesnut (A'19, M'36), L. M. Ilgenfritz, and A. Kenner (A'25).

3. Crystal Channel Filters for the Cable Carrier System, by C. E. Lane (A'36).

4. Crosstalk and Noise Features of Cable Carrier Telephone System, by M. A. Weaver, R. S. Tucker (A'26), and P. S. Darnell.

The carrier system described is intended for use on toll cables, which for this purpose are operated without loading coils. Twelve channels are provided and the system is intended for use over distances as great as 4,000 miles. Cables of existing types may be used but the high attenuation for carrier frequencies of from 12 to 60 kilocycles requires the insertion of a repeater every 17 miles on the average. Channel filters employing quartz crystals as filter elements are used. In addition, however, the inductance coils, some of the capacitors, and also the filter assemblies each embody new features.

Discussion followed the presentation of the papers. W. H. Capen (M'23) of the International Telephone and Telegraph Corporation, New York, N. Y., described briefly the cable carrier system installed by the British Post Office between Bristol and Plymouth, England. The equipment differs somewhat from that described at this session, but it is said to give satisfactory reproduction of voice when the 12 channels are looped in such a way as to produce an equivalent circuit approximately 1,500 miles in length. E. Ireland (M'31) American Telephone and Telegraph Company, New York, N. Y., referring to the commercial uses of the broad-band cable system, stated that it is expected that some eight or nine hundred miles of cable equipped with carrier will be in commercial service by the end of 1938. Other discussions indicated that some difficulty is expected from interference of the carrier relay systems of power companies and also their carrier communication circuits with the new open-wire-line carrier circuits but it is anticipated that the difficulties can be solved.

Some of the apparatus used in the cable carrier system, including a crystal channel filter with cover removed, aluminum-coated quartz crystals, crosstalk balancing coils, and a line amplifier were exhibited.

Television

Two addresses were presented at the session on television: "Current Field Work in Television," by Ralph R. Beal, Radio Corporation of America, and "The Coaxial Cable System for Television Transmission," by M. E. Strieby, (M'22) Bell Telephone Laboratories.

The first of these addresses described the system of radio television now being used in field tests and summarized the present objectives. The tests now being conducted embrace studies of fundamental standards, propagation of ultrahigh frequencies, measurements of the field intensity necessary for satisfactory reproduction of pictures, studies of the sources of interference, studies of polarization in the transmitted wave, observations on the functioning of the equipment, installation of the equipment, and the development of a studio program technique.

In the system described, the image is dissected into elements, converted to electrical impulses, transmitted, and reconverted to light. Lenses focus the image on a thin mica diaphragm, the front surface of which is covered by a photosensitive mosaic, within the pickup tube. A stream of electrons is directed upon the diaphragm, controlled by suitable means for scanning the area. A metal plate on the back of the diaphragm is connected to the output circuit; the output is proportional to the amount of light falling into each element of the picture. The receiving tube is a cathode-ray tube in which a beam of electrons the intensity of which varies according to the signal, is focused upon a fluorescent target which forms one end of the tube. Suitable means are also provided here for scanning. In order that the picture may be reproduced, the electron ray in the receiving tube must be synchronized with the ray in the pickup tube at the transmitter. In order that television broadcasting may be possible on a commercial scale, some standard system for synchronization must be decided upon. The standard at present proposed is 441 lines per frame, with 30 frames or pictures transmitted per second. However, in order to reduce flicker, interlaced scanning is used; this means that the beam scans first lines 1, 3, 5, etc., and then returns and scans lines 2, 4, 6, etc. Thus the frame frequency is said to be 30 per second, and the field frequency 60 per second. A synchronizing impulse is transmitted at the end of each line, and at the end of each frame. It is not necessary that the power systems supplying the receiver and the transmitter be interconnected; if the frequencies are regulated sufficiently closely for the operation of electric clocks, synchronism in the television system can be maintained.

Transmission of the signals requires a wide frequency band. In order to accommodate this, a channel width of 6 megacycles is used, including both "video" or picture signal, and the accompanying audio or sound signal.

Tests are being conducted from a transmitter on the top of the Empire State Building, New York, with programs received from the NBC studios in Radio City over either a radio link or a coaxial cable. Sig-

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Vice-Chairman, District No 5.
National Membership Committee

als on 46.5 megacycles are transmitted to xperimental receivers located at various oints in the metropolitan area. Programs originate either from studio presentaons or from motion-picture film. Reently, a mobile pickup unit was added in ne form of two motor busses, one provided ith the equipment for picking up both elevision and sound programs, and the ther carrying a transmitter which is used s a link between the mobile unit and the nain transmitter. The production of teleision programs is expected to require the rowth of a new art, for it will differ from resent stage, screen, and radio programs.

Photographs of images on the receiving ube and various pieces of equipment were nown by means of slides. Television, it as said, will supplement rather than suplant the other existing agencies of comunication.

The second address described a system nat was designed primarily for conducting xperimental work on coaxial cables. Mehanical scanning is used to produce a 240 ne picture at the rate of 24 frames per econd. It was explained that the idea of ne coaxial cable was conceived originally or telephone circuits, and that its developnent for the transmission of television gnals has been incidental, pending comnercial needs. In this television system, a pecially designed cathode-ray tube is used t the receiver. Slides were used to show ne equipment and some of the pictures that ave been transmitted.

Ratings Discussed at Welding Session

Much discussion as to the information hat should be put on the name plate of elding transformers was presented at the ession on electric welding, over which V. E. Crawford, chairman of that comnittee, presided.

A report of the subcommittee on resistnce welding was presented by C. L. feiffer (A'21, M'27) of the Western Elecric Company, Inc., Chicago, Ill. Under he title "Recent Advances in Resistance Velding," the report was published in the RANSACTIONS section of the January issue, ages 37–8. Some distribution systems or welders were described by L. W. Clark A'25) of The Detroit Edison Company; ne low-reactance conductor made from oncentric tubes, the outer one grounded nd the inner one tapped at intervals, suplies welders up to 800 feet from the transormer.

Control equipment for pneumatically perated portable welding tools operating t speeds of 350 or more welds per minute vere described in the paper "Mechanical High-Speed Resistance-Welder Control" y F. H. Roby (A'37) of the Square D Company, Milwaukee, Wis. (*EE, Sept. 37, p. 1145–8*).

The third paper to be presented at the ession was "Interpretation of Oscillograms f Arc-Welding Generators in Terms of Velding Performance," by K. L. Hansen, A'17, F'34) of the Harnischfeger Corporaion, Milwaukee, Wis. He stressed the elation between the transient volt-ampere characteristics of the welding generator and the stability of the arc. Present specifications for tests for the transient performance of welding generators were held to be inadequate.

The last paper to be presented at the session was "The Rating of Resistance Welding Transformers," by C. E. Heitman (M'35) of the Edward G. Budd Manufacturing Company, Philadelphia, Pa., which is published in the TRANSACTIONS section of this issue, pages 125–30. Additional nameplate data were recommended and a standard rating for resistance welding transformers was urged. Availability of the proper information would enable the user to shift the transformer from one job to another with assurance of satisfactory performance. The discussion which followed was presented from the view point of both users and manufacturers. Dual rating of welding transformers—a rating for the transformer alone, and a rating for the machine as a whole—was suggested. Other suggestions called for giving the maximum amount of current that the machine could supply and for ratings on the highest and lowest secondary taps. Some fear was expressed that too much information would be put on the name plate. It was also pointed out that retention of the present name plate would avoid confusion.

From the manufacturer's point of view, it was said to be commercially out of the question to determine the resistance and reactance in order to give this information. Some manufacturers provide curves showing the primary and secondary currents.

The advantage of taps over phase control was illustrated in a discussion that pointed out that phase control introduces harmonics in the primary circuits. Mr. Roby believed that suitable standards would be a great aid in selecting the proper contactor for a given application.

The desirability of giving equipment as small a rating as possible was also brought up, with reference to the local inspection for compliance with codes, the cost of which depends upon the installed capacity. It was pointed out that some inspectors do not appreciate the fact that, because of different duty cycles, a welding transformer of given rating may not require wiring as heavy as that specified in codes.

Transients Illustrated at Transmission Session

Motion pictures which show transients on transmission lines by means of animated diagrams were shown at the session on power transmission, thereby illustrating a paper on this subject in a way that is impossible in printed form. Other papers in this session discussed the lightning strength of wood, system recovery-voltage characteristics, switching surges, and joint use of wood poles. Raymond Bailey, vice-chairman of the power transmission and distribution committee, presided.

The first paper on the program for the session, was "Transmission Line Transients in Motion Pictures," by L. F. Woodruff (M'33) of Massachusetts Institute of Technology, Cambridge. The paper described the preparation, for educational purposes, of motion pictures showing traveling waves on transmission lines, by a method similar to that used in producing animated cartoons. Data were determined experimentally on an artificial line by the use of cathode-ray oscillographs, and voltage distribution curves for successive instants of time were plotted, cut from black paper, and photographed against a white background which carried a representation of the system, and showed operations such as the movement of switches. D-c transients have been studied in this way, and the film that was presented showed transients on lines having various terminal conditions, such as open, short-circuited, or terminated in the surge impedance. The effect of these conditions on voltage and polarity was clearly illustrated. Another film was presented by L. V. Bewley (A'27) of the General Electric Company, Pittsfield, Mass. This was devoted to the traveling waves caused on transmission lines by lightning strokes. Lightning potential was shown to build up between clouds and earth until finally a stroke caused a wave of high potential to travel along the line. Behavior of the wave for various conditions was shown; for example, as an insulator flashed over, because of the time lag in the flashover, part of the lightning wave continued on along the transmission line, while the remainder was reflected back. The building up of overvoltages at transformers and at inductances in the line also was illustrated.

Tests of the insulation value of wood were reported by J. T. Lusignan, Jr., co-author with Philip Sporn of the paper "Lightning Strength of Wood in Power Transmission Structures," which was published in the TRANSACTIONS section of the February issue, pages 91–101. Conclusions reached were that wood has a definite field of application in supplying insulation against lightning voltages on wood structures, and that the impulse insulation of wood in structures alone and in combination with porcelain may be calculated with some degree of certainty. Time was said to be important in considering the insulation strength of wood; the holding strength for very short impulses is much higher than would be obtained by a long-time measurement.

A study made on an a-c calculating board was reported in the paper "Recovery-Voltage Characteristics of Typical Transmission Systems and Relation to Protector Tube Applications," by R. D. Evans (A'21, M'26) and A. C. Monteith (A'25) of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. The data on recovery voltage are applied particularly to the use of protector tubes. In service, the bore of the tube erodes and increases in diameter; the insulation recovery characteristics of the tube are lower as the bore increases, and eventually the protector will fail to clear. Analysis and operating experience indicates that the insulation-recovery characteristic does not change at an impractical rate. In discussion, it was pointed out that an accurate background of field tests is necessary in order that proper use might be made of the a-c calculating board. C. N. Weygandt (A'37) University of Pennsylvania, Philadelphia, suggested an equivalent circuit to avoid errors from capacitance in the calculating board.

An investigation to determine the magni-

tude and characteristics of the abnormal voltage transient accompanying the operation of load-ratio control contactors on power transformers was described in the paper "Switching Surges With Transformer Load-Ratio Control Contactors," by L. F. Blume and L. V. Bewley of the General Electric Company, Pittsfield, Mass. (*EE, Dec. '37, p. 1464–75*). In d-c switching, overvoltages as great as 72 times normal were reported. It was emphasized, however, that the paper dealt with a special type of circuit interruption, and that the result could not be extrapolated to apply to circuit breakers.

The last paper presented at this session was "Protection Features for the Joint Use of Wood Poles Carrying Communication Circuits and Power Distribution Circuits Above 5,000 Volts," by J. O'R. Coleman (A'23, M'29) Edison Electric Institute, and A. H. Schirmer (A'13, M'29) Bell Telephone Laboratories, Inc., New York, which is published in the TRANSACTIONS section of this issue, pages 131–40. The historical development of joint use was reviewed, and safety measures described.

Industrial Applications Rule Electronics Symposia

Eight papers embracing many of the divers applications of electron tubes were presented at the two symposia on electronics held during the winter convention. Papers presented at the morning session were concerned chiefly with industrial applications of thyratrons and similar tubes, but those presented during the afternoon session were concerned with some of the new applications of vacuum tubes. H. M. Turner, chairman of the AIEE joint subcommittee on electronics, presided.

The complete list of papers is as follows:

1. ELECTRONIC SPEED CONTROL OF MOTORS, **E. F. W. Alexanderson** (A'04, F'20) and **M. A. Edwards**, General Electric Company, Schenectady, N. Y., and **C. H. Willis** (A'22, M'28) Princeton University, Princeton, N. J.

2. THE THYRATRON MOTOR AT THE LOGAN PLANT, **A. H. Beiler** (M'35) American Gas and Electric Service Corporation, New York, N. Y.

3. PHANOTRON RECTIFIERS AS A DIRECT-CURRENT SUPPLY FOR ELEVATOR MOTORS, **C. C. Clymer** and **R. G. Lorraine** (A'29, M'36) General Electric Company, Schenectady, N. Y.

4. THYRATRON CONTROL OF DIRECT-CURRENT MOTORS, **G. W. Garman**, General Electric Company, Schenectady, N. Y.

5. SHARP CUT-OFF IN VACUUM TUBES, WITH APPLICATIONS TO THE SLIDE-BACK VOLTMETER, **C. B. Aiken** (M'35) and **L. C. Birdsall** (Enrolled Student) Purdue University, Lafayette, Ind.

6. THYRATRON REACTOR LIGHTING CONTROL, **E. D. Schneider** (A'32) General Electric Company, Schenectady, N. Y.

7. AN ELECTRONIC ARC-LENGTH MONITOR, **Walther Richter** (M'37) A. O. Smith Corporation, Milwaukee, Wis.

8. A NEW TYPE VACUUM SEAL, **W. Endres Bahls**, RCA Radiotron Division, Harrison, N. J.

MOTOR CONTROL APPLICATIONS

In presenting the first paper Professor Willis stated that "The development of power tubes provides a new approach to the problem of variable-speed motors. This appears to be one of the most promising fields for large tubes and rapid progress may be expected in this direction. A great variety of combinations may be produced, and those familar with the art will recognize that only a start has been made in using power tubes to control the speed of an a-c motor."

Professor Willis described three different arrangements employing electronic devices for controlling the speed of a motor operating from an a-c power supply: a synchronous motor using thyratrons as a commutator, the wound-rotor induction motor using a rectifier and d-c motor on the secondary, and a phase-controlled rectifier supplying a d-c motor from an a-c power source. Following a formal presentation of the paper M. A. Edwards, co-author, demonstrated some thyratron speed-control equipment, showing in a practical way the remarkable flexibility and smoothness of thyratron control. Doctor Alexanderson discussed broadly the future of electronic control in industrial fields, and stated that even under present limitations the control of 4,500 horsepower might be accomplished conveniently by the use of electron tubes.

A. H. Beiler's paper described a thyratron motor used for driving an induced-draft fan in the Logan plant of the American Gas and Electric system. The author stated that the motor is giving satisfactory operation in every respect, except that tube failures seem to be too frequent; however, one of the discussers of the paper pointed out that electron tubes frequently must be redesigned to give satisfactory life characteristics for specific applications, and that eventually the frequency of tube failures for this application may be reduced. The average life of the tubes used in the thyratron motor thus far has been roughly 5,000 hours.

In areas where public utilities have curtailed or completely eliminated the d-c power supply to concentrated load areas the change from d-c to a-c power supply for elevators requires a substitution of a-c elevator equipment or the use of converters to supply direct current to the existing elevator equipment. According to Clymer and Lorraine, a phanotron rectifier possesses many advantages in areas where a converter must be used. Their paper described in detail some trial equipment, which was placed in operation in 1935, and which has been in continuous operation since.

G. W. Garman asserted that in the speed control of d-c motors the thyratron has the advantage of high efficiency, full control, and quickness of response. The small control energy required and the quickness of response simplify the design of precision control circuits and reduce hunting. The paper described some feed-back control circuits and their characteristics.

OTHER APPLICATIONS

The principle of the slide-back voltmeter is not new, but Professor C. B. Aiken pointed out that this valuable instrument has been much misused. Ordinarily the slide-back voltmeter produces accurate results only if the voltage to be measured is reasonably large. Professor Aiken showed that for certain conditions the current-voltage characteristics of vacuum tubes obey an exponential law, and showed how this characteristic could be applied to the measurement of peak values of sinusoidal voltages much smaller than those usually measured by this type of instrument.

E. D. Schneider described three types of individual intensity-control units, a master intensity-control unit, and a scene fader for use in theater lighting, and described in detail some of the new equipment, new systems, and new theatrical practices made possible by the use of the thyratron tube.

In describing a new electronic arc-length monitor, Walther Richter delineated another of the manifold applications of vacuum tubes in industry. The instrument described is useful primarily in the training of welders to hold a steady arc at the voltage best suited for the welding electrode. The output of the arc-length monitor is connected to two small lamps in the welder's helmet, one of which indicates that the arc voltage drop is lower than normal, and the other that it is too high. Mr. Richter stated that in training men with this instrument all welders could be trained to the technique best suited for the particular electrode, and that new men acquired the ability to hold a steady arc in about one-third the time usually required without the instrument. The author asserted that an arc-length monitor is not a cure-all for welding difficulties, but that it simply eliminates one of the many variables in electric welding.

The problem of leading insulated electrical conductors into metal containers that must be hermetically sealed for many years has been a difficult one, according to W. Endres Bahls. He described many of the seals between metal and glass, and described in some detail a new type of metal-glass-porcelain seal, which is expected to be useful primarily for large radio and power tubes. Mr. Bahls stated that this type of seal probably will not be economically feasible for use in small radio receiving tubes because the cost of the individual seal is relatively high. Nevertheless "the possible uses of a seal of this type are many and varied . . . in fact, it may be used wherever an electrical lead into a hermetically sealed container is desired."

Tests and Current Ratings Discussed at Cable Session

At the session on cables and research held during the winter convention, marked differences of opinion were expressed by those discussing the papers: "Oil Oxidation in Impregnated Paper" by J. B. Whitehead (A'00, F'12, past-president) of The Johns Hopkins University and T. B. Jones of the Bell Telephone Laboratories, Inc.; and "Mechanical Uniformity of Paper-Insulated Cable," by K. S. Wyatt (A'32), D. L. Smart (A'37) and J. M. Reynar of the Detroit Edison Company. The session was opened by W. B. Kouwenhoven, Chairman of the AIEE committee on research; after brief remarks, he turned the meeting over to R. D. Evans, Chairman of the AIEE committee on power transmission and distribution, who presided thereafter.

A series of studies of the oxidation process in cable paper impregnated with oil con-

taining different amounts of oxygen are recorded in the Whitehead and Jones paper, presented by Doctor Whitehead, which was published in the December 1937 issue, pages 1492–51. On the basis of their experiments, the authors concluded that small amounts of oxygen have a relatively unimportant effect on the electrical characteristics of oil-impregnated paper insulation; also that impregnation in oxygen results in better characteristics than impregnation in air, apparently because of the better absorption of oxygen by the oil. The authors further concluded that the continued process of oxidation rather than the products of oxidation is the cause of oil and paper deterioration, and that small amounts of oxygen either combine or go into solution without serious impairment of electrical properties.

Several discussers disagreed with the conclusion that oxygen has an unimportant effect on cable insulation, suggesting that perhaps a test duration of only seven days is insufficient to make the results applicable to field conditions. It was thought also that tests at higher temperatures and under conditions that would simulate load cycles might throw further light on the problem. In closing the discussion, Doctor Whitehead recognized that the study should be extended in many directions, including time duration. He said that the chief value of the results is in the comparison of electrical characteristics versus oxidation.

President W. H. Harrison delivering his winter-convention address

The paper presented by Doctor Wyatt, who recently was appointed technical director of the Enfield Cable Works, Ltd., Brinsdowne, Surrey, England, describes a method of preparing cross-sectional wafer specimens of cable sufficiently thin to be translucent. This paper is published in the Transactions section of this issue, pages 141–54. A study of wafer specimens cut from representative cables has led the authors to conclude that mechanical uniformity is the foundation of cable quality; also that the study of mechanical uniformity throws open the door to improvement of high voltage cable in several directions, and that improvement in mechanical uniformity should make possible the use of solid cable at 100 kv or more without resort to pressure devices to suppress ionization.

Several discussers, mostly representatives of the various cable manufacturers, disagreed with these conclusions. W. A. Del Mar (A'06, F'20) Habirshaw Cable and Wire Corporation, Yonkers, N. Y., said that carefully made laboratory cables which were mechanically somewhat superior to commercially made cables, were not much better than the commercial products in other respects. R. J. Wiseman (A'16, F'27), Okonite Company, Passaic, N. J., emphasized the necessity for caution in interpreting the results of the paper, and called attention to the work that the cable manufacturers are doing as regards the problem of uniformity of paper tension while wrapping. R. W. Atkinson (A'09, F'28), General Cable Corporation, Perth Amboy, N. J., said that inferior cables may show good wafer specimens. He considered the most important result of the paper to be the showing of the spaces between the conductors and the insulation.

Current Ratings Need Revision

Formulas for calculating the allowable current-carrying capacities for wires and cables installed in buildings were presented by S. J. Rosch (A'15) of the Anaconda Wire and Cable Company, Hastings-on-Hudson, N. Y., in his paper "The Current-Carrying Capacity of Rubber-Insulated Conductors." These formulas are the outgrowth of an investigation initiated in 1931 by the rubber insulated wire and cable section of the National Electrical Manufacturers' Association and conducted by a committee of which the author was chairman. Mr. Rosch outlined briefly the historical background leading up to the investigation and called attention to the changes in design and chemical composition of rubber covered wires and cables, together with changes in building materials and installation methods, which emphasize the need for a revision of allowable current-carrying capacities. He expressed the hope that not only will the results of this investigation be reflected in a revision of future code ratings for rubber-insulated cables, but also that the factors established by the investigation will be used by others for the revision of existing current-carrying-capacity tables for other types of insulated cables.

In discussing this paper, W. A. Del Mar called the paper an exceedingly important one and expressed the opinion that it will be used as a reference work for many years. Herman Halperin (A'21, M'26) of the Commonwealth Edison Company, Chicago, Ill., voiced the opinion that further thought should be given to the abandonment of "code" rubber in favor of a better product. D. W. Ver Planck (A'31) Yale University, New Haven, Conn., called attention to the longitudinal thermal conduction from equipment at the terminals of cables that may have an allowable temperature rise greater than that of the cables, and expressed the opinion that this must be taken into account in establishing allowable current ratings for the cables.

Limiters

In the final paper presented at this session, C. P. Xenis (M'37) of the Consolidated Edison Company of New York, discussed "Short-Circuit Protection of Distribution Networks by the Use of Limiters." This paper was published in the September 1937 issue, pages 1191–6. The limiter consists of a reduced metallic section incorporated in a connector, lug, or other connecting device used in normal cable installation procedure. It has a time-current characteristic calculated to protect the cable to which it is connected over a wide range of short-circuit currents, and is designed to form an integral part of the joint or cable terminal without the necessity of the additional enclosures, terminal blocks, or packing glands that conventional underground fusing systems require. In short, it is a fuse made into an inconspicuous part of the cable it is intended to protect. Mr. Xenis said that 40,000 of these devices have been installed by the Consolidated Edison Company, and that they now are being installed at a high rate. He described several instances in which these devices had functioned to clear faults with a minimum of damage to the system. He pointed out that all of the limiters on both sides of a fault do not necessarily need to blow in order to clear the fault.

Diversified Discussion at Machinery Sessions

A formula useful in the design of transformers; methods of testing power transformers, including some specific recommendations directed to the electrical machinery committee for the revision of existing transformer test codes; stray-load-loss tests of d-c machines; and unsymmetrical operating conditions of a-c machines—these were the subjects discussed at the two winter-convention sessions on electrical machinery. J. L. Hamilton, chairman of the AIEE committee on electrical machinery, presided. The papers presented were as follows:

1. Co-ordination of Power Transformers for Steep-Front Impulse Waves, **V. M. Montsinger** (A'14, F'29) General Electric Company, Pittsfield, Mass.

2. Corona Voltages of Typical Transformer Insulations Under Oil, **F. J. Vogel** (A'21) Westinghouse Electric and Manufacturing Company, Sharon, Pa.

3. A Formula for the Reactance of the Interleaved Component, **H. B. Dwight** (A'11, F'26) and **L. S. Dzung** (Enrolled Student) Massachusetts Institute of Technology, Cambridge.

4. Stray-Load Losses of D-C Machines, **E. W. Schilling** (A'29, M'33) Michigan College of Mining and Technology, Houghton, and **R. W. Koopman** (A'36) University of Kansas, Lawrence.

5. D-C Machine Stray-Load-Loss Tests, **Victor Siegfried** (A'32) Worcester Polytechnic Institute, Worcester, Mass.

6. Unsymmetrical Short Circuits on Water-Wheel Generators Under Capacitive Loading, **C. F. Wagner** (A'20, M'27) Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

7. Overvoltages Caused by Unbalanced Short Circuits (Effect of Amortisseur Windings), **Edith Clarke** (A'23, M'33) and **C. Concordia** (A'31) General Electric Company, Schenectady, N. Y., and **C. N. Weygandt** (A'37) University of Pennsylvania, Philadelphia.

8. Alternator Short-Circuit Currents Under Unsymmetrical Terminal Conditions, **A. R. Miller** (A'18) and **W. S. Weil, Jr.** (Enrolled Student) Lehigh University, Bethlehem, Pa.

Although greatly improved in impulse strength within the last two years, modern high-voltage transformers cannot withstand the voltages associated with excessive steep-front lightning waves proceeding from direct strokes on or near its terminals. The intelligent co-ordination or protection of transformers for all kinds of impulse waves requires an accurate knowledge of the volt-time characteristics of transformer insulation, and many data of this variety were presented in the first paper, by V. M. Montsinger, whose conclusions were based upon several thousand front-of-wave and impulse tests of transformer insulation. In presenting the second paper, which was closely related to the first in objectives,

F. J. Vogel stated that insulation deterioration usually is caused by corona or local discharges in the oil and over solid insulation surfaces; test results show that air entrapped within the insulation structure may reduce the dielectric strength severely, and that placing the tank of the transformer under vacuum while it is being filled with oil is helpful in expelling this difficulty.

The two papers concerning the measurement of stray-load losses of d-c machines were discussed enthusiastically. Both papers presented variations or adaptations of the loading-back methods of Kapp, Hutchinson, and Blondel, with particular emphasis on making the methods adaptable to commercial test requirements. Several discussers enthusiastically endorsed the method and suggested that the committee on electrical machinery consider the inclusion of this method in the AIEE test code for d-c machinery in place of the existing arbitrary factor of one per cent for stray-load losses.

The last three papers described somewhat specialized problems in analyzing short circuits unsymmetrically applied to a-c machines. The paper by C. F. Wagner and the paper by Edith Clarke, C. Concordia, and C. N. Weygandt, outlined some of the effects of damper windings during such unsymmetrical short circuits, and all three papers presented analyses by the method of symmetrical components.

Matrices, Ferroresonance Basic Sciences Topics

With E. E. Dreese, chairman of the AIEE committee on basic sciences, presiding, the following five papers were presented at the basic-sciences session of the winter convention:

1. Matrices in Engineering, **L. A. Pipes** (A'37) The University of Wisconsin, Madison.

2. Resonant Nonlinear Control Circuits, **W. T. Thomson** (A'37) Kansas State College, Manhattan.

3. Subharmonics in Circuits Containing Iron **I. A. Travis** (A'32) and **C. N. Weygandt** (A'37) University of Pennsylvania, Philadelphia.

4. The Properties of Three-Phase Systems Deduced With the Aid of Matrices, **M. B. Reed** (A'36) The University of Texas, Austin.

5. Critical Conditions in Ferroresonance, **P. H. Odessey** (Enrolled Student) and **Ernst Weber** (A'31, F'34) the Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

Matrices in Engineering Problems

In presenting his paper, Doctor Pipes stated that much matrix theory is buried in erudite mathematical tomes, and that his purpose in preparing the paper was to present to engineers a method of analysis which, although not new, has been long neglected. One of the principal advantages of the matrix method in engineering is in avoiding unwieldy manipulations of many equations. Doctor Pipes did not pretend that the matrix method is simpler or more rapid than somewhat more conventional methods of analysis, but claimed that one of the main virtues of the method is its unity of approach. That is, the matrix method may be used for solving completely a complicated equation or system of equations, but conventional solutions may require several types of operations. Doctor Joseph Slepian (A'17, F'27) in discussing Doctor Pipes' paper particularly commended the author for introducing the little known Cayley-Hamilton theorem in engineering literature, and enthusiastically endorsed this paper as "epoch making."

Professor Reed, whose paper is closely related in subject matter to the paper presented by Doctor Pipes, pointed out that the matrix method does not require strange concepts for the solution of electrical systems. The solution normally may be evolved from a conventional statement of Kirchoff's laws.

Nonlinear Circuit Applications

The so-called ferroresonant type of nonlinear circuit containing a resistor, a capacitor, and a saturable-core reactor is finding several applications in various engineering fields, some of which were described in the papers by Thomson, Odessey and Weber, and Travis and Weygandt. W. T. Thomson described some features of the superposition of a d-c magnetizing force on the reactor and offered a mathematical analysis for the criteria of stability and amplification. Mr. Thomson's paper was presented by Professor Reed.

T. F. Barton, chairman, winter convention committee, speaking at the "general" session

Of the various methods employed in the study of ferroresonance, the graphical method of solution, according to Weber and Odessey, presents itself as the most flexible and gives a somewhat better physical picture of the phenomenon. They proposed a rule for the criteria of stability, determining the critical conditions and permitting analytic developments of formulas defining the critical quantities.

Travis and Weygandt described an interesting method of analyzing the characteristics of subharmonic oscillations in circuits containing iron-cored inductors, using as a basis of analysis the simplest known circuit that exhibits the ferroresonance anomaly. The step-by-step methods were checked by means of a differential analyzer, and the solutions obtained by the two methods were found to agree surprisingly well. Although the authors started with an extremely simple hypothetical circuit, they indicated that gradually they are discarding some of the initial simplifications, and demonstrated a mechanical calculator for solving the attendant complex mathematical expressions.

Several discussers related experiences in which irregularities germane to ferroresonance had caused puzzling results; others expressed a disliking for the term "ferroresonance," because the effect is not closely related to the ordinary concept of resonance in electric circuits, and the name is likely to be misleading. In his closing discussion Mr. Odessey pointed out that the term "ferroresonance" is not intended to be descriptive but is used as a matter of convenience because one of the early investigators adopted the term in his nomenclature, and the name never has been discarded.

Network Analyzers Feature Instruments Session

In companion papers, H. P. Kuehni (A'29) and R. G. Lorraine (A'29, M'36) of the General Electric Company, Schenectady, N. Y., described a new a-c network analyzer and H. A. Thompson (A'37) of the same company described a stabilized electron-tube amplifier used in conjunction with the analyzer, at the winter-convention session sponsored by the AIEE committee on instruments and measurements. H. C. Koenig, chairman of the committee, presided.

By means of the amplifier described by Mr. Thompson, a 50-volt 50-milliampere base is used in the analyzer, and at the same time measuring instruments of conventional type can be utilized. Because of the small currents and voltages, capacitive and inductive reactance between leads of the analyzer units have a negligible effect on the results. Power is supplied to the analyzer by adjustable single-phase 480-cycle generator units of compact design. Scales of all analyzer circuit units and instruments are marked in per cent to facilitate conversion to power-system quantities.

In the discussion of this paper L. A. Nettleton (A'21, M'26) of the Consolidated Edison Company of New York reported having made a series of studies on the new analyzer on the basis of which he considered the unit to be well-designed and easy to operate. Other discussers emphasized the usefulness of the network analyzer in solving power-system problems. H. L. Hazen (A'26) of the Massachusetts Institute of Technology called attention to two limitations involved in network-analyzer design: the instrumentation, and the proper proportioning of the various network units, the latter being a matter of careful design. He said that the instrumentation of the new unit represents a new step in analyzer design, but that this improvement does not render present analyzers obsolete.

Studies of Living Tissue

The third paper in this session, "Electrical Studies of Living Tissue—II" by A. G. Conrad (A'27), H. W. Haggard, and B. R. Teare (A'29, M'36) all of Yale University, New Haven, Conn., was presented by Doctor Conrad. This paper was published in the Transactions section of the January issue, pages 1–4. Doctor Conrad mentioned various theories concerning the response of living tissue to electric shock, and said that on the basis of their experiments he and his associates had concluded that response occurs when the threshold voltage has been built up in the tissue. The results presented in this paper constitute an extension of those reported in an earlier paper on the same subject (*EE, July '36, p. 768–72*).

In discussing this paper, J. H. Lotz of The Johns Hopkins University, Baltimore,

Md., reported average minimum perceptible currents, as measured by experimenters at Johns Hopkins, of 0.017 ampere for women and 0.023 ampere for men, using a rectangular wave. He called attention to the fatigue effect observed in making these experiments, which resulted in an increase in the minimum perceptible current after any one subject had been subjected to several successive tests. K. S. Cole of the Columbia University medical school, reported observing an enormous change in tissue at the time stimulation from electric current takes place, this change being manifested by a tremendous increase (200 times) in the conductance of the tissue.

In the final paper, D. W. Ver Planck (A '31) of Yale University presented "A New Correlation of Sphere-Gap Data." This paper was published in the TRANSACTIONS section of the January 1938 issue, pages 45–9. Based upon the similarity principle for electrical discharges, this paper presents a correlation of the most recent AIEE sphere-gap data for both positive and negative impulses.

Public Relations Prominent in Symposium on Vehicles

Public relations formed the keynote of the presentation of nine papers and most of the discussion at the two sessions of a symposium on modern electric vehicles, held January 24, the first day of the winter convention. G. I. Wright, chairman of the AIEE committee on transportation, presided. The formal papers presented were:

1. THE PCC STREET CAR, C. F. Hirshfeld (A'05, F'36) Transit Research Corporation, Detroit, Mich.

2. APPLICATION OF MODERN ELECTRIC VEHICLES TO URBAN TRANSPORTATION, C. M. Davis (A'08) General Electric Company, Erie, Pa.

3. ELECTRICAL EQUIPMENT FOR MODERN URBAN SURFACE TRANSIT VEHICLES, S. B. Cooper, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

4. RESULTS OF OPERATION OF PCC CARS IN PITTSBURGH, Thomas Fitzgerald (A'02) Pittsburgh Railways Company, Pittsburgh, Pa.

5. MODERN CITY TRANSPORTATION, E. J. McIlraith, Chicago Surface Lines, Chicago, Ill.

6. MODERN TROLLEY-COACH OPERATION, Edward Dana, Boston Elevated Railway, Boston, Mass.

7. MODERN TROLLEY-COACH OPERATION, J. H. Polhemus, Portland Electric Power Company, Portland, Ore.

8. OPERATING EXPERIENCES WITH GAS-ELECTRIC-DRIVE MOTOR BUSSES, R. H. Stier, Philadelphia Rapid Transit Company, Philadelphia, Pa.

Following the presentation of these eight papers, Martin Schreiber (A'03) Public Service Co-ordinated Transport, Newark, N. J., described some of the operating experiences of that company, a pioneer in the evolution of the "all service vehicle," in the co-ordination of a transportation system carrying many millions of passengers each year. Mr. Schreiber described a highly desirable type of public reaction to the operation of the all-service vehicle in the New Jersey metropolitan area, and asserted enthusiastically that the Diesel-electric type of bus will provide even better service and will effect improved operating characteristics. He stated that, based upon a relatively short period of experience, the operating characteristics of Diesel-electric busses seem to be superior to gasoline-electric vehicles in reliability and safety, and to be superior in the economy of maintenance and operation.

Doctor Hirshfeld's paper was presented by C. G. Gordon, one of his associates in the Transit Research Corporation, who believes that the PCC car represents an outstanding example of the results of industrial research, because the entire process of modernization has taken place within the operating companies. Few other types of equipment are evolved in this way.

C. M. Davis stated that no one can write a universal formula for the application of modern electric vehicles to urban transportation, because each individual community has its own peculiar transportation problems and only one type of mass transportation vehicle is best applicable to the solution of that problem. Only one paper, that of S. B. Cooper, dealt with design and structural details of the electrical equipment for surface transit vehicles. The papers by Thomas Fitzgerald, E. J. McIlraith, Edward Dana, J. H. Polhemus, and R. H. Stier, all described operating experiences with modern electric vehicles in various parts of the United States, and under widely differing conditions. E. J. McIlraith's paper was presented by W. H. Rogers of the Brooklyn and Queens Transit Corporation, Brooklyn, N. Y.; Edward Dana's paper was read by W. H. Sawyer (A'02, F'13) of the Peoples Railway Company, Dayton, Ohio; and the paper by J. H. Polhemus was read by L. C. Josephs, Jr. (A'11, M'19) a member of the engineering staff of the International Motor Company, Allentown, Pa., who was associated with the author in some of the early phases of the modernization of the Portland (Ore.) transportation system.

Among several guest speakers was C. W. Chase, president of the American Transit Association and president of the Indianapolis Railway Company, Indianapolis, Ind., who described how the transportation system of that company, bankrupt financially and physically and in labor and public relations in 1932, has been placed upon a solid economic foundation by means of a thorough modernization of the system and a consequent improvement in the quality of operations and public relations.

Following the presentation of the papers, two motion pictures were presented through the courtesy of Martin Schreiber: one depicted some operating characteristics of the Public Service all-service vehicle; the other was a new sound picture entitled "Your Neighborhood," which was designed to show that with modern urban and interurban transportation facilities a whole state indeed may become a part of one's own neighborhood.

Session on Relays and Reactors

Relays, reactor applications, and temperature limits were discussed in papers presented at the session on relays and reactors, over which K. B. McEachron, vice-chairman of the committee on protective devices, presided. Relay contacts highly damped to prevent chattering, use of harmonics to restrain relays, and temperature limits based on the aging of insulation were described.

A study of the current, voltage, and power values throughout a simple transmission system when machines are operating out of

A few of the 1,201 who attended the smoker

Top, left to right: E. L. Moreland, past chairman, Boston Section; C. L. Gilkeson, New York, N. Y.; V. M. Montsinger, chairman, standards committee, Pittsfield, Mass.; Director K. B. McEachron, Pittsfield; and W. A. McMorris, Pittsfield

Bottom, left to right: G. M. L. Sommerman, 1937 Noble Prize winner, Worcester, Mass.; President W. H. Harrison, New York; Vice-President J. P. Jollyman, San Francisco, Calif.; National Secretary H. H. Henline, New York; Past-President C. E. Skinner, Wilkinsburg, Pa.; and Vice-President E. D. Wood, Louisville, Ky.

step was described in the paper "A System Out of Step and Its Relay Requirements" by Leslie N. Crichton (A'08, M'21) Westinghouse Electric and Manufacturing Company, Newark, N. J. (*EE, Oct. '37, pp. 1261–7*).

Presenting the paper "A New High-Speed Distance-Type Carrier-Pilot Relay System," which was published in the TRANSACTIONS section of the January issue, pages 5–10, S. L. Goldsborough (A'24), co-author with E. L. Harder (A'30) and B. E. Lenehan (A'24) Westinghouse Electric and Manufacturing Company, described a one-cycle relay scheme which combines the high-speed and back-up characteristics of step-type distance protection with the simultaneous tripping feature possible with a pilot circuit. Bouncing of the relay contacts is minimized by using a moving contact in the form of a silver capsule partially filled with finely powdered tungsten. Friction developed in the sliding of the tungsten particles absorbs the energy of the impact of the contacts and prevents bouncing.

Several problems in relaying were discussed in the paper "The Application and Performance of Carrier Current Relaying" by Philip Sporn (A'20, F'30) and C. A. Muller (M'36) of the American Gas and Electric Service Corporation, New York, N. Y., which is published in the TRANSACTIONS section of this issue, pages 118–24. Improper operation was reported in about one per cent of the total number of times carrier was called upon to block. L. C. Traver (A'10, M'20) General Electric Company, Philadelphia, Pa., predicted perfect operation when adjustments are finally completed.

A new method to prevent the operation of differential relays on unbalanced currents which may sometimes flow in their circuits when no internal fault is present, was described in the paper "Harmonic Current Restrained Relays for Differential Protection," by L. F. Kennedy (A'37) and C. D. Hayward (A'28) of the General Electric Company, Philadelphia. False operation may be caused by departure of current-transformer ratios from their normal values, magnetizing inrush current in power transformers, and magnetizing inrush current in current transformers. Saturation of current-transformer cores and magnetizing inrush current will produce harmonics in the relay circuit, and advantage of this has been taken to restrain operation of the relay. The paper created considerable discussion; questions were raised by R. M. Smith (A'35) Westinghouse Electric and Manufacturing Company, Newark, and T. W. Trice (A'36) Consolidated Gas, Electric Light and Power Company of Baltimore, as to the effect on the relay of the large variety of wave shapes that may be encountered and of off-frequency operation, such as might follow a fault. The latter also raised a question regarding the checking of the operation of the relay restraining element inasmuch as harmonics would not be available during normal operation. Mr. Kennedy said that the frequency characteristics may be controlled by design.

H. P. Sleeper (A'22, M'30) Public Service Electric and Gas Company, Newark, N. J., called for simpler relays with less contacts, and described how increasing the time constants of relay operation might produce the same result as the use of the more complicated and special relays. There were, he said, no manufacturing rights for this arrangement. Other discussion was presented relating to the application of carrier to cable lines, in which it was pointed out that operation will be satisfactory on cables having solid sheaths, but that it will not be satisfactory on cables using bonding transformers.

Aging of insulation for various overloads was discussed in the paper "Temperature Limits for Short-Time Overloads for Oil-Insulated Neutral Grounding Reactors and Transformers" by V. M. Montsinger (A'14, F'29) of the General Electric Company, Pittsfield, Mass., which was published in the TRANSACTIONS section of the January issue, pages 39–44. An enthusiastic discussion was presented to the effect that design on the basis of aging units would be more economical, and that by extension of the principle co-ordination of motors and transformers in railway equipment would now be possible.

The final paper was "Some Schemes of Current-Limiting Reactor Applications," by F. H. Kierstead (A'15, M'29) of the General Electric Company, Pittsfield. Three schemes for using the reactance to limit fault current and at the same time minimize its effect during normal operation were described: reactors shunted by circuit breakers, saturable-core reactors, and split-circuit reactors. The author favored split reactors for feeder circuits and ring busses.

Reports of Five Technical Conferences Held During the Winter Convention

TO PROVIDE opportunity for the direct informal interchange of ideas on subjects of a specialized nature among specialists and others interested in such subjects, five technical conferences were held during the AIEE 1938 winter convention. Brief reports of these conferences are presented here. These reports were prepared by the conference chairmen, or from notes furnished by them, except the conference on education, which was prepared by the conference secretary.

Definitions

By Michel G. Malti, Chairman

The small attendance at this conference (about 20) was not a measure of the interest displayed for discussion was very lively indeed and four persons who were unable to attend sent written discussions.

Discussion was restricted mostly to the definitions in section 05 of group 05 of the First Revised Report of the Sectional Committee (*C* 42) on Definitions of Electrical Terms. Among those present were H. L. Curtis (A'21, F'26) of the National Bureau of Standards, Washington, D. C., chairman of subcommittee 1 of committee *C* 42; and W. J. Shackelton (A'12) of the Bell Telephone Laboratories, New York, N. Y., and C. V. Christie (A'08, F'32) of McGill University, Montreal, Canada, members of the committee; all three took part in the discussion.

The subcommittee on definitions of the AIEE committee on basic sciences, sponsor of this conference, plans to prepare revisions of other sections of group 05 of the definitions and submit these revisions for discussion at future technical conferences.

Education

By A. D. Hinckley, Secretary

Because of the illness of J. W. Barker, chairman of the AIEE committee on education, O. W. Eshbach, former chairman of the committee presided at this conference. Mr. Eshbach first outlined the program that had been planned by Dean Barker, discussing the need for better correlation of such basic subjects as mathematics and physics with each other as well as with the subjects following in the engineering curriculum. The considerable discussion that developed indicated definitely that a technical session on this subject at the AIEE 1938 summer convention would be of value. There was considerable discussion from the floor as to the proper methods of instruction in mathematics and physics; the efforts at various schools to integrate the study of mathematics and physics; of the problem as to whether physics and mathematics should be taught by engineers or scientists trained in engineering or whether they should be taught by pure scientists; of the problem of compensation for those science teachers giving instruction to engineering students. Representatives of several engineering colleges reported that definite co-ordination in the science work was being attempted at their respective institutions. At the conclusion of the discussion, Mr. Eshbach suggested that a committee be appointed to prepare a program for the forthcoming summer convention.

The next subject pertained to the professional engineering activities of engineering teachers. Representatives of various schools discussed the situation in regard to their own institutions and indicated the problems particularly as they represented conflict with organizations of professional engineers in the several states. In concluding this discussion, Mr. Eshbach asked Professors E. E. Dreese and W. L. Everitt of The Ohio State University, Columbus, to serve as a committee to collect such information as they could on this problem.

Past-President C. F. Scott, chairman of the Engineers' Council for Professional Development, described the present program being developed by that body. He indicated that attempts were being made to improve the presentation of papers of general and educational interest in the publications of the several member societies of ECPD and asked for suggestions as to how such improvements could be made. There was a general discussion as to what should be the subject matter and form of presentation of such articles as would be of value to the young engineer.

Network Analysis and Synthesis

By Edward L. Bowles, Chairman

A strong array of talent was represented in the group of more than 90 attending this conference. The consequent discussion therefore was uniquely valuable and to the point. The program of prepared discussions was as follows:

1. Linear Transformations and Equivalent Electrical Networks, by R. S. Burington, Case School of Applied Science, Cleveland, Ohio.

2. Some Practical Applications of the Theory of Linear Network Transformation Showing its Utility and Limitations, by E. A. Guillemin, (A'24) Massachusetts Institute of Technology, Cambridge.

3. Some Aspects of Simple Filter Design Where Attenuation Is the Controlling Factor, by W. N. Tuttle, General Radio Company, Cambridge, Mass.

4. Discussion of Network Problems as Applied to Television, by R. D. Kell.

5. Equalizers for Transmission Circuits, by W. R. Lundry.

This selection of subjects was as broad in its presentation as in its scope. Those in the audience who were not too familiar with "linear transformations" seemed to be awakened on the one hand by Doctor Burington and thoroughly aroused on the other by Doctor Guillemin whose illustrations were simple and direct.

Dr. Tuttle's presentation dealt with the filter design problem from the point of view of an engineer applying filter theory ideas to broad, rather poorly behaved fields, as compared to the well-mannered and almost ideal one in which the filter designer usually operates in telephone practice. This presentation started liberal discussion.

The presentation of the television network problems elicited many handsome comments. From the remarks after the meeting, it was evident that this paper opened many opportunities to those networks men who perhaps have not examined this field for problems. It laid a good foundation for a future conference on network problems and their solution in this field.

The presentation by Mr. Lundry on equalizers was particularly satisfactory in that it gave one a good idea of the state of this difficult field with respect to the theoretical and applied network aspects. Both as to conciseness and precision as well as to the selection of material, this speaker left a feeling of deep interest.

Radiation Fields

By Ernst Weber, Chairman

The strong interest in such fundamental and basic discussion as transpired at this conference was indicated by the attendance, which was about 90 to 100 people during most of the conference.

S. A. Schelkunoff (M'34) of the Bell Telephone Laboratories, New York, N. Y., presented the generalized concept of impedance as applied to radiation problems in electromagnetic, sound, heat, and elastic phenomena. He illustrated, in very striking manner, the analogy between transmission-line phenomena and shielding phenomena, which in the past usually were treated with extensive mathematical apparatus.

H. F. Olson of RCA-Victor Division, Camden, N. J., followed this by illustrating the close analogy between sound and electromagnetic wave propagation, showing acoustical radiation patterns quite analogous to antenna radiation patterns. He outlined the analogy still further in detail in reference to sound producing and sound receiving equipment.

H. Poritsky of the General Electric Company, Schenectady, N. Y., finally gave applications of the radiation concepts to the propagation of elastic waves in solids, such as vibrations in shafts with varying cross sections, and seismological studies.

These very interesting presentations were followed by considerable discussion led by L. A. Hazeltine (F'35) of Stevens Institute of Technology, Hoboken, N. J., who gave a novel way of simple derivation of laws of electromagnetic as well as sound radiation. M. G. Malti (M'34) of Cornell University, Ithaca, N. Y., questioned the application of the impedance concepts to general transmission line problems and particularly the value of the operational impedance concept. L. A. Pipes (A'37) of the University of Wisconsin, Madison, discussed a problem involving variable line parameters. H. W. Bibber (A'21, M'30) of Ohio State University, Columbus, inquired about the limitations of the mathematical treatment of elastic waves. K. W. Miller (A'23, M'29) of the Utilities Research Commission, Chicago, Ill., J. J. Smith (A'19) of the General Electric Company, Schenectady, and others also took part in the discussion.

Sound and Vibration Measurement

By P. L. Alger, Chairman

The conference on noise and vibration measurement bringing together some 25 experts and 150 interested listeners, gave evidence of the rapid progress being made in this new field. Discussion at this conference centered upon experiences with sound-level meters and their calibration, and detailed codes for measuring the noise from specific types of apparatus.

The sound-level meters provided for by the ASA standards are of the objective type, with readings in decibels, proportional to the logarithm of the ratio of the actual root-mean-square noise energy level to the reference energy level of 10^{-16} watts per square centimeter. For high noise levels the readings are unweighted, but for medium and low noise levels weighting networks are provided which weight each frequency component in proportion to its audibility. Harvey Fletcher (M'23, F'30) of the Bell Telephone Laboratories, New York, N. Y., pointed out that for intermittent noises like the exhaust of a motorcycle, these meters give an average noise reading well below the momentary peak values, and thus fail to indicate the real nuisance value of the noise. A. J. Muchow pointed out also that when superposed click noises form an appreciable part of the noise produced by small apparatus, the resultant sound level as read by a meter is several decibels lower than that indicated by ear comparisons. Chiefly for this reason of inadequate measurement of fluctuating noises, the International Standards Association has deferred the acceptance of the objective type of noise meter as standard. Various types of meters which indicate peak noise levels rather than the average are under development abroad,

A few of the 651 who attended the dinner-dance

Top, left to right: Mrs. George Sutherland, chairman, women's entertainment committee, New York, N. Y.; C. W. Franklin, member of committees on power transmission and distribution, and production and application of light, New York; Chairman J. B. Harris, Jr., of the Philadelphia Section; E. F. Pearson, chairman of the 1938 Pacific Coast convention committee, Portland, Ore.; Past Vice-President B. D. Hull, St. Louis, Mo.; and J. C. Chayton, London, England

Bottom, left to right: Past Vice-President Mark Eldredge, Memphis, Tenn.; J. H. Lampe, counselor, Johns Hopkins University Branch, Baltimore, Md.; Director C. R. Jones, New York; Past Director L. W. W. Morrow, Corning, N. Y.; Mrs. G. H. Stickney, Cleveland, Ohio; and J. L. Scanlon, past-chairman, Niagara Frontier Section

and the whole subject of international standards will be reconsidered at the ISA meeting in 1939. It was generally agreed, however, that the American sound-level meters now available give a satisfactory measure of the nuisance value of ordinary types of noise, and for comparative and research purposes are far preferable to the older listening methods of evaluation.

C. R. Hanna (A'24) of the Westinghouse Company, East Pittsburgh, Pa., presented a report of the ASA subcommittee on fundamental sound measurements, noting that satisfactory methods now have been established for calibrating microphones, and that agreement has been reached to rely upon the National Bureau of Standards as the responsible source of fundamental measurement standards.

V. R. Chrisler of the Bureau of Standards, Washington, D. C., reported briefly on the sound-measurement work of the bureau and showed calibration curves obtained on two generally used types of sound-level meters. While maximum differences of as much as 10 decibels occurred at some points in the frequency range, he stated that the causes of these variations from the standards now are well understood, and soon may be corrected.

J. M. Barstow (A'35) of the Bell Laboratories, secretary of the ASA committee on standards for sound-level meters, described progress made by that committee in studying the subject since the issue of the standards some time ago. He pointed out that the chief problem now remaining is the development of a secondary standard sound source, or acoustical calibrator, which can be sent from one laboratory to another for reference purposes, just as the standards of length and other fundamental measurements now are compared. He described a device of this sort consisting of a chamber under fixed air pressure from which air escapes through a small orifice into the center of a larger chamber. The larger chamber serves as a resonator for low frequency and attenuator for high frequency, making the output-energy distribution over the frequency range suitable for general noise-calibration purposes. M. S. Mead described another secondary standard noise source consisting of a whistle giving a note of a definite loudness and pitch, which has been used with considerable success in calibrating meters. A third type of calibrator developed in Germany consists of a vessel filled with buckshot with a small orifice similar to an hour glass. When the vessel is inverted the shot drop onto a standard resonating diaphragm, making a definite noise with a wide frequency spectrum. Mr. Barstow described plans of his committee to circulate these standard acoustic calibrators among all laboratories of sound-meter manufacturers. In conclusion, he stated that the excellent co-operative attitude of all those concerned gives promise of a speedy solution of the calibration difficulties, which are holding up the satisfactory use of sound-level meters.

A. P. Fugill (A'24, M'30) of the Detroit Edison Company talked on his experience in making noise measurements on transformers during the past five years. Measurements have been made on 175 different transformers varying from 100 to 6,000 kva, with a great variety of different ratings and types of construction, and repeat readings taken under given conditions have been found to check very satisfactorily even after considerable length of time. While originally most of the measurements were made out of doors, to minimize sound-reflection difficulties, recent tests have shown that noise-level measurements in an ordinary warehouse room with a clearance of several feet from the transformer to the nearest wall agree within one or two decibels of outdoor readings, so that for convenience future tests will be made indoors when practicable.

Mr. Fugill's conclusion from this experience was that noise specifications for transformers and other sorts of apparatus are desirable for both manufacturers and users of apparatus, as they enable the purchaser to know just what he is getting in the way of quiet apparatus, and the manufacturer to be sure he is meeting the user's requirements. The Detroit Edison Company has actually adopted purchasing specifications for transformers which include specific requirements for noise measurement, and the same practice is being extended to gears. To avoid a multiplicity of different specifications set up by different users, and to aid in the development of accurate information on noise levels, Mr. Fugill strongly recommended that the AIEE machinery committee and other interested groups co-operate in the development of detailed test codes for all types of apparatus. J. J. Smith (A'19) of the General Electric Company, Schenectady, N. Y., pointed out that a committee of the National Electrical Manufacturer's Association has been considering this question of test codes for specific types of apparatus for some time, and that progress is being made. The consensus of the meeting was that this work should be carried on in an orderly way, but that in view of the still unsatisfactory meter-calibration situation and the wide variations due to varying conditions of test, any attempt to rush matters would cause confusion and ultimately delay progress.

Mr. Fugill and others emphasized the point that no attempt should be made to set up specific noise-level values at this time and that all effort should be concentrated on the adoption of agreed methods of test and the collection of basic information. The value of sound-level meters at present is more in the detection and control of defective apparatus or faulty conditions of use than in the exact measurement of noise.

Following the discussion on noise, Mr. Mead reviewed the subject of vibration measurement. Anyone who investigates noise with any care soon finds that one of the most important problems in noise control is the prevention of sound transmission through vibrating structures. Elastic machine supports and nonresonant wall and building construction thus become an essential part of the problem. To study these questions, it becomes necessary to measure vibration. The displacement of a vibrating surface is not alone a sufficient description of a motion, as normally vibrations are of a complex character involving many frequencies. The velocity of the vibration is perhaps the most satisfactory over-all measure of the noise production, but for very high frequency the acceleration of the motion is also useful. Thus it becomes necessary to have instruments suitable for separate measurement of the displacement, the velocity, and the acceleration of vibration, and it is desirable to establish standard definitions and units of measurement in this field.

It is customary to speak of the amplitude of a vibration, meaning thereby the total, or double range, displacement of the motion. The term amplitude, however, also is used generally to describe the range of variations of any variable, whether velocity acceleration, or displacement. Confusion arises in translating from the term amplitude to velocity, as factor 2 must enter to allow for the double range implied by the term amplitude. Mr. Mead recommended, therefore, that the term displacement be standardized to describe the single amplitude of motion. He also suggested that curves showing the relative sensitivity with which different frequencies of vibration can be felt by the fingers or other human senses be determined, similar to the audibility curves for different frequencies of sound.

In conclusion, Mr. Mead offered the following list of instruments now available for measuring vibration, and suggested that experience in using them be accumulated and published for the benefit of those working in this field (table I).

The intense interest in the whole field of noise and vibration evidenced by the attendance at this conference, and the well-known public interest in quieter living conditions, indicates the importance of further work by Institute committees and other organizations in the development of improved instruments and measurement methods. While no definite plans for future meetings have been made, it was suggested that if suitable papers covering actual noise measurement are received by the committee, a formal technical session on noise and vibration should be arranged for a future Institute convention.

Table I

Instruments Available	Approximate Range
Displacement	
1. Dial indicator	10 to 45 cycles; 1 to 20 mils
2. Vibration-amplitude recorder	6 to 200 cycles; ¼ to 10 mils
3. Light-beam indicator	12 to 500 cycles; ¼ to 10 mils, 1 to 30 mils
4. Integrating vibration-velocity meter	10 to 1,500 cycles; ¼ to 60 mils
5. Velocity unit with SLM and analyzer	60 to 5,000 cycles; 10^{-3} to 60 mils
6. Strain gauge	0 to 500 cycles; 10^{-2} to unlimited mils
7. Displacement—brush crystal DP1	10 to 500 cyles; depends on amplifier
Velocity	
1. Vibration-velocity meter	10 to 4,000 cycles; 1 to 18,000 mils per second
2. Velocity unit with SLM	40 to 4,000 cycles; 10^{-3} to 10^{4} mils per second
Acceleration	
1. Brush or RCA crystal	30 to 1,800 cycles; depends on amplifier

Edison Medal for 1937 Presented to Gano Dunn

With simple but fitting ceremony, the Edison Medal for 1937, highest award of the AIEE, was presented to Gano Dunn at a special session of the Institute's 1938 winter convention, for "distinguished contributions in extending the science and art of electrical engineering, in the administration of great engineering works, and for inspiring leadership in the profession." Mr. Dunn has been president of the J. G. White Engineering Corporation, New York, N. Y., since its organization in 1913. He is a life member of the AIEE. His affiliation with the Institute dates from 1891, when he became an Associate; he was transferred to grade of Member in 1894, and to Fellow in 1912. He has served the Institute in many capacities during his long affiliation, having been a manager from 1897 to 1900 and from 1902 to 1905; vice-president from 1900 to 1902 and from 1905 to 1907; and president 1911–12. He has served on many Institute committees and as AIEE representative on other bodies.

President W. H. Harrison presided over the ceremonies, introducing first Past-President H. P. Charlesworth, chairman of the Edison Medal committee, who spoke briefly on the history of the medal and the conditions governing its award. It is awarded annually by a committee of 24 members to a resident of the United States or Canada, "for meritorious achievement in electrical science, electrical engineering, or the electrical arts."

At the conclusion of Mr. Charlesworth's remarks, President Harrison introduced Past-President Bancroft Gherardi who sketched the high lights of Mr. Dunn's career. The essential substance of Mr. Gherardi's address follows.

Medalist Dunn's Career Outlined by Bancroft Gherardi

"In the brief time available it is not easy to tell of the medalist's achievements because there have been so many of them. His distinction does not rest upon a few things which he has done, but rather upon a multitude of accomplishments, each well worth while. They are notable for their diversity of character.

"His career from its beginning is one of which his many friends are rightly proud. He acquired a good education under conditions that made it necessary for him to work during the hours when he was not attending classes or studying. He first went to the College of the City of New York and in 1889 received from that institution the degree of bachelor of science with the distinction of a Phi Beta Kappa key. Then, going to Columbia University, he received the degree of electrical engineer in 1891. Later, in 1897, he received from the C.C.N.Y. the degree of master of science. During the period from 1886 to 1891 he worked for the Western Union Telegraph Company as a night telegraph operator. During the years in which he was acquiring his formal education he became acquainted with Francis B. Crocker, the president of The Crocker-Wheeler Electric Manufacturing Company, and Michael I. Pupin. Both of these men were at that time professors at Columbia University. Each of them later became president of the AIEE. With these men, outstanding in engineering and in science, Dunn's ability and personality made an immediate impression and earned their respect and their lasting friendship.

"Upon completing his work at Columbia University in 1891 he accepted a position with the Crocker-Wheeler company. Almost immediately he demonstrated his scientific knowledge and practical judgment by improving the design of its product and showing how to overcome certain difficulties which were being experienced by the users of its motors. These were seriously threatening the success of the business. The value of his services was appreciated and he earned rapid promotion in this company until he became its vice-president and chief engineer, a position which he held until 1911. Those of us who can still remember the electric motors of that time know of the high standing of those manufactured by the Crocker-Wheeler company and the extent to which this was due to the understanding and abilities of Gano Dunn. Although one of the smaller independent electrical manufacturers, this company successfully withstood and still withstands the keen competition of its larger rivals, due in considerable measure to the contributions made by its former chief engineer. Many of these were of such a nature that they were not patentable. In addition, he is credited with over 30 patents having to do with the design and construction of electrical machinery....

"In 1911 Dunn's personality and professional standing caused James Gilbert White, the founder and head of J. G. White and Company, to offer him a vice-presidency of that company, which offer he accepted. He assisted Mr. White in organizing the J. G. White Engineering Corporation, and in 1913 became its first president. This position he has held continuously since then. He has been and still is a major factor in the growth and splendid achievements of that corporation. Its name and his name are known throughout the world and in practically every continent there will be found numerous examples of engineering and construction which testify to the standing and ability of the company and of its president....

The Roster of Edison Medalists

1909	Elihu Thomson
1910	Frank J. Sprague
1911	George Westinghouse
1912	William Stanley
1913	Charles F. Brush
1914	Alexander Graham Bell
1916	Nikola Tesla
1917	John J. Carty
1918	Benjamin G. Lamme
1919	W. L. R. Emmet
1920	Michael I. Pupin
1921	Cummings C. Chesney
1922	Robert Andrews Millikan
1923	John W. Lieb
1924	John W. Howell
1925	Harris J. Ryan
1927	William D. Coolidge
1928	Frank B. Jewett
1929	Charles F. Scott
1930	Frank Conrad
1931	E. W. Rice, Jr.
1932	Bancroft Gherardi
1933	Arthur E. Kennelly
1934	Willis R. Whitney
1935	Lewis B. Stillwell
1936	Alex Dow
1937	Gano Dunn

Activities in Engineering Organizations

"When I have referred to Dunn's engineering achievements it might be supposed that, as I am speaking of an engineer, I have said about all that there is to say. This assumption, however, would be far from the facts. One of the characteristics of the medalist is the broad scope of his interests and activities. Every engineer owes an obligation to his profession aside from his work as an engineer. This obligation Dunn has assumed as a privilege and he has more than performed his share in the organized undertakings of his profession.

"He has taken an active part in the management of the AIEE. He has served on its governing board as a manager and as a vice-president, and during the year 1911–12 he was its president. Even to day he is remembered by those who knew him at that time as one of its most able and effective administrators.

"He was a leader in the formation of The Engineering Foundation and had much to do with securing the splendid endowments presented to that organization by Ambrose Swasey. Dunn was the first chairman of The Engineering Foundation.

"He was prominent in connection with the starting of the United Engineering Society [now United Engineering Trustees, Inc.] the organization which holds, on behalf of the four national engineering societies, the building in which this meeting is being held. For a number of years he was a member of the board of that society and was its president during the years from 1913 to 1916.

"The National Research Council felt the benefit of his association with it and from 1923 to 1928 he was its chairman and chief executive officer.

"He has had important associations with international congresses and other organizations which only time prevents my mentioning.

"One of my stimulating associations with Gano Dunn was during the war. At that time there was naturally much concern in the minds of the authorities at Wash-

ington as to the possibility of the trans-Atlantic telegraph cables being cut, thus interrupting or crippling telegraphic communication with our associates in the war and with our military forces in Europe. To be prepared for such a contingency our State Department appointed a special committee on submarine cables and Gano Dunn was its chairman. Several members of this committee were representatives of the telephone and telegraph industry in the United States. It was my good fortune to be one of these. Associated with the committee were attachés representing the army and the navy. This committee made a complete study of the problem and, under its general direction, experimental work was carried on so that all possible ways of meeting such an emergency in communication with Europe were explored. Fortunately, conditions did not arise which made it necessary to meet the contingency for which the committee was appointed, but, throughout, the skill with which the chairman of the committee directed its work was noteworthy.

Activities Outside Engineering

"Engineering, however, does not circumscribe Dunn's activities. He is also interested in science, which lies at the foundation of engineering. He has maintained a private laboratory at his home primarily for the satisfaction of his own intellectual curiosity. Illustrative of the breadth of his interests, and to me quite significant, is the fact that at one time Dunn took the necessary courses, passed the required examinations and secured a first-class commercial radio operator's license. He wants to know about things and likes to do things....

"He has been a member of the National Academy of Sciences for many years and has established for himself a position of leadership in that distinguished scientific organization. For three years he served as chairman of its engineering section.

"His interest in science and engineering has not been limited to this country. He is a member of important engineering organizations abroad.

"No man who worked so industriously to secure an education should, after securing it, lose interest in such matters and give no thought to contributing something to the opportunities that may be open to others. Dunn has given generously of his time and wisdom to the management of institutions of higher learning. He has served as a trustee of Columbia University, of Barnard College, and of the Cooper Union for the Advancement of Science and Arts. Today he is the president of Cooper Union, and through his effective work and rare abilities he has contributed in a large measure to its welfare and its growth.

"Many men become associated with organizations of one kind or another without showing any particular interest in the purposes of such institutions or taking an active part in their management. This, however, is not the method of Gano Dunn. Over past years he and I have been associated together in many organizations. Always he has taken an understanding and a helpful part in the direction of affairs.

"He is an honorary member of organizations outside of the engineering field and has received several honorary degrees and other awards of distinction....

A Diplomat Without Portfolio

"Of the many characteristics which go to make up our medalist, which are more clearly demonstrated by his accomplishments than by anything that I could say, I wish to mention just one which is perhaps somewhat unusual in an engineer. Combined with straight thinking and with frankness, which many engineers possess, he has diplomatic abilities of no mean order. He is one of the few engineers, perhaps the only one whom I know, who in my judgment could represent this country adequately, gracefully and in a creditable manner as the head of our embassy near the Court of St. James.

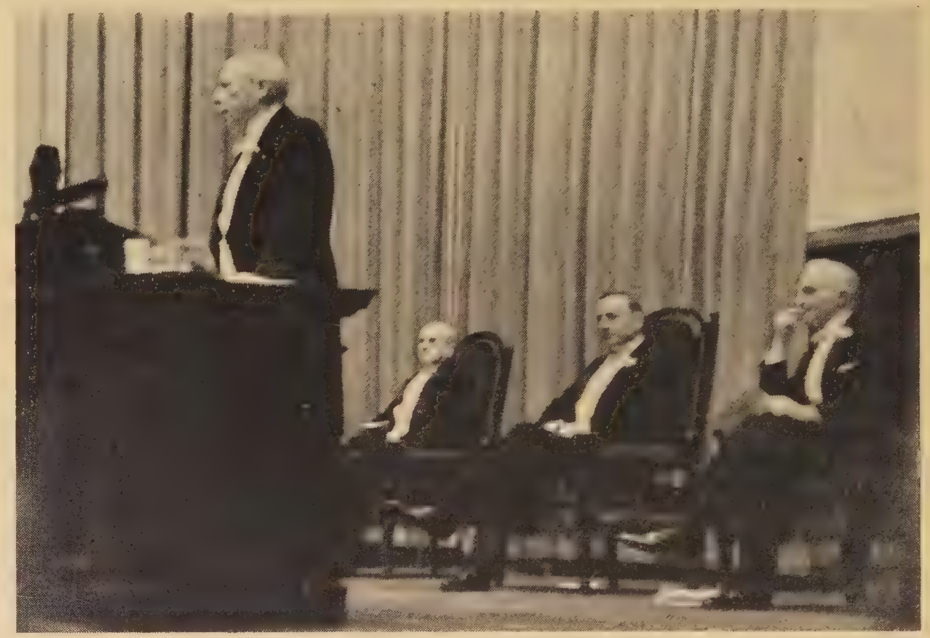
"I congratulate the Edison Medal committee and the engineering profession on the selection of the medalist. They are honoring an engineer, a student of science, a man of affairs, a diplomat without portfolio, and a loyal friend."

Mr. Dunn Praises Edison

Following Mr. Gherardi's address, President Harrison presented the medal and certificate to Mr. Dunn, who responded, in part, as follows:

"I am overwhelmed by this honor, which has more meaning for me than anyone can ever know, for Thomas Alva Edison was one of the gods of my boyhood and from then on he has been one of the profoundest inspirations of my life.

"I am also embarrassed by the presentation of Bancroft Gherardi, himself an Edison Medalist. His name adds luster to the Edison Medal galaxy. The merits of the accomplishments he has set forth I am forced to deprecate, for they seem to me to be overestimated. But to the extent that my selection for the award represents the respect, the good will, and the affection of the leaders of the profession among whom my life's work has been cast, I seize upon and cherish the honor as one greater than I had ever dreamed of, and as a token of that something that is priceless above all estimate—the judgment of one's peers.



On the platform at the Edison Medal ceremonies, left to right: Past President Bancroft Gherardi outlining the career of Medalist Dunn; seated are Past Presidents H. P. Charlesworth, chairman of the Edison Medal committee, and Gano Dunn, who received the medal, and President W. H. Harrison; also seated on the platform, but out of range of the camera, was National Secretary H. H. Henline

"For me this particular stamp of gold is enriched by and will forever enshrine personal associations with its great exemplar. These associations started at a time when, working my way through the College of the City of New York as a night telegraph operator in the employ of the Western Union Telegraph Company, a kind friend, Mr. Somerville, then head of the Associated Press, gave me a letter of introduction to Mr. Edison at the Harrison Lamp Works.

"Out of an almost infinite kindness for young men who were struggling, and particularly out of the Scottish clannishness that existed then, and still exists, between all telegraph operators, Mr. Edison received me in the midst of some laboratory work he was doing in the coating of laminated armature plates for the prevention of Foucault currents in the then novel long-legged belt-driven generators that energized the first Edison lighting systems.

"Seeming to be interested in the questions I asked him, he drew me out in turn and spent an hour personally showing over his lamp works the boy who had come to visit him. At the end of the visit, he offered me a job, which only the urgent and wise advice of several of my professors at college kept me from taking, to the abandonment of further formal education, even though this abandonment would have meant relief

from the struggle of staying at college.

"I still cherish two of the first one-candle power lamps that were ever made, which Mr. Edison picked from a box and handed me as a present when I left. He did not complain that I did not take his job, and he afterward said I was right.

"After graduation from the City College and later from Columbia University in the first electrical-engineering course that had been formally organized in this country, I saw him from time to time at his various laboratories, and on two occasions he called on me when I was vice-president and chief engineer of The Crocker-Wheeler Electric Manufacturing Company at Ampere, N. J., near his Orange laboratories, for the purpose, he said, of finding out what had been the developments in the research work which I had been conducting for several years on the commutation of d-c generators. In a few searching questions he extracted all I knew and pointed out fruitful directions in which to continue the work.

"While my every contact with him was a thrill and a fresh polarization, I will not further retail these personal associations, except to add one of which I am very proud. At a time when the president of the AIEE was chosen by competitve elections, and when the procedure involved a primary nomination campaign as well as a final campaign for the election itself, Mr. Edison in a letter to the then secretary, Mr. Ralph W. Pope, which I now possess, took the lead in nominating me for the presidency. This largely contributed to my becoming the formal nominee of the board of directors ticket.

"As often happened in those days, the directors ticket was challenged by an opposition ticket, and in the contest which followed numerous circulars were issued to the whole membership of the Institute, than about 8,000 strong, which took a keen and active part in the balloting. In order to take part in the preparation of one of these circulars, which was in the hands of Doctor Charles P. Steinmetz, Mr. Edison sent to Doctor Steinmetz a Western Union telegram, which I also now have, saying: 'You can use my name for Gano Dunn as he is a friend of mine.'

"But whereas these personal relations account for part of the profound influence exerted on an eager young man, and the firing in him of an ambition to become an electrical engineer and to develop in the wonderful electrical field of miracle and magic, they represent only the personal side of that universal respect and even reverence felt by all electrical engineers for the accomplishments of one of the greatest geniuses the world has ever known.

"When he was born Nature certainly did let loose a thinker on this planet, with all the consequences of that act.

"Wherever the picture is held up to view of the world's development in the last generation with respect to the technological gifts from on high, of inventions which have lifted burdens from the back of labor, increased the conveniences and comforts of mankind, developed the resources of nature, fostered intercommunication and the life of peoples, and raised the standard of human living with accompanying leisure for recreation, for thought and for mental and spiritual development, the great strokes of the brush of Thomas A. Edison will be found to have painted a large part of that picture.

"Not only were the lights that shine upon us at this moment evolved by him, but also the constant-potential multiple-arc distribution system by which they are fed. It has become practically the only system used throughout the world, and it is perhaps his greatest invention. It is so great and has become so common and so universal that today we are hardly more conscious of it than of the air we breathe...."

Mr. Dunn then mentioned some of the many significant contributions of the great inventor including: the carbon telephone transmitter, the first successful motion-picture camera and projector, the iron-nickel alkaline storage battery, the stock ticker, the automatic telegraph and the quadruplex, his observation of the "Edison effect," his invention for the magnetic separation of iron ores, and his work in electrical transportation and in cement making.

"Much of Edison's work," he continued, "was in making practical and useful to the public, theories and ideas that were in existence but which lacked for their success essential features which his inventive genius and his indefatigable labors supplied in the creation of a whole that previously did not exist.

"But in the case of the phonograph he was the author of the whole creation. Just as the name of Alexander Graham Bell will never die on account of his having been the first to give to the world the means of transmitting human speech to unlimited distances, so if everything else that Edison ever did should be forgotten, his name will never die on account of his having been the first to give to the world the means of recording human speech for all time.

"We are all familiar with the present day uses of the phonograph, but it is possible that posterity will regard these uses as ephemeral in comparison with the value of the records of speech and of great music and other natural sounds of our day, of which the beginnings of great phonograph libraries are already indicating the profound future importance.

"All these children of Edison's brain have grown since they were born, and in their growth they in turn have called forth industry after industry, and benefit after benefit to man. The vast copper industry of today rests largely on the electrical cornerstone which Edison laid.

"I mean no disparagement to the work of other geniuses who have contributed to these same fields, but if there is applied the favorite test of the late John J. Carty of calculating the consequence to this engineering world of ours by suddenly removing Edison's contributions, we should experience an utter cataclysm, which would speak in tones of thunder the debt of man to Edison's genius.

"Just as he polarized the boy telegrapher and inspired his life, so he has inspired the lives of unnumbered other electrical engineers and workers in the field of engineering, endowing them with a gift by which in smaller ways they have carried in countless directions little lights ignited by his great torch.

"The Edison Medal was founded, not to perpetuate his memory, for that can never die; but as a stimulus to oncoming engineers to greater achievements, and as testimony to our capacity for appreciating what he did and recognizing the immeasurableness of our debt to that great painter of the picture of our technological world.

"As the picture still goes on, with its embellishments and developments, and records each triumph in the field of the electrical engineer which peculiarly claims Edison as its own, there is not lacking in the hearts and minds of all electrical engineers who have dipped their brush in his pregnant pigment and thereby added to the world's great canvas, a proud consciousness which enables them each in his own smaller way to exclaim in the language of the humble pupil as he gazed upon one of Raphael's great works, 'I too am a painter.' And as I shall look upon the honor and the prized possession of this medal in the years that are to come, my heart will be truly humble and at the same time proud in the consciousness that even a little puddle can reflect the sun."

Student Counselors Hold Annual Luncheon Meeting

Some 45 student counselors and others interested in the work of the AIEE Student Branches, were present at the Town Hall Club, New York City, January 25, for the annual meeting of this group that is held as a part of the winter convention program. Dean F. Ellis Johnson, chairman of the committee on Student Branches, reported briefly on the work of the committee during the past year, including projects initiated or considered as a result of suggestions made at last year's conference. With reference to the projected "News Letter" concerning Branch activities, he discussed the progress made to date stating that to be effective, the reports now being made would need to be broadened to include more than information of a routine nature. A brief discussion of the means followed by various Branches in interesting eligible students in membership led to a suggestion that this topic be reported upon specifically by various Branches in order that the information might be exchanged.

The booklet issued by the Institute in 1931 under the title "The Electrical Engineer—Some Facts Concerning Electrical Engineering as a Career," was the subject of extensive discussion, the point being whether or not to reissue the booklet. Some 10,000 of these booklets were issued by the Institute in 1931 in memory of the centennial of Michael Faraday's success in 1831 "in obtaining electricity from ordinary magnetism." In addition to a brief biographical sketch of Faraday, this booklet gave an outline of salient features of electrical engineering as a profession, intended to assist a prospective engineering student to choose a life work for which his own characteristics best suit him. One phase of the question at issue was whether the booklet, "Engineering—A Career—A Culture" (issued by, and available from, The Engineering Foundation) served the whole purpose of student orientation, thus supplanting the Institute booklet. The ultimate consensus of opinion was that these two book-

lets effectively supplement each other, the Foundation booklet for use in secondary schools, and the Institute booklet for use among college freshmen; the republication of the Institute booklet was recommended, and the project left in the hands of chairman F. Ellis Johnson.

A brief discussion among those present indicated that electrical-engineering students are considered eligible for membership in Student Branches during their junior and senior years in most cases, during the sophomore year in some instances, and seldom during the freshman year. The question of allowing credit for participation in Student Branch meetings brought out discussion indicating that in the great majority of instances attendance and participation are fully voluntary and no credit given; that in some instances the activity is considered as an elective subject for which credit is permitted; in some few instances participation is required on a seminar basis, and credit allowed accordingly. The preponderance of expressed opinion was in support of the idea of voluntary student participation.

Doctor Charles F. Scott, chairman of the Engineers Council for Professional Development, spoke at some length concerning the objectives of that jointly sponsored agency of the engineering societies.

After a brief discussion of the apparent trend of the current publication policy as exemplified in the development of Electrical Engineering during recent months, the luncheon group took action strongly in support of the direction of the publication committee's current policy, urging further development in the same direction.

AIEE Directors Meet During Winter Convention

The regular meeting of the board of directors of the American Institute of Electrical Engineers was held at Institute headquarters, New York, N. Y., January 26, 1938.

There were present: *President*—W. H. Harrison, New York, N. Y. *Past-Presidents*—A. M. MacCutcheon, Cleveland, Ohio; J. B. Whitehead, Baltimore, Md. *Vice-Presidents*—O. B. Blackwell, New York, N. Y.; L. T. Blaisdell, Dallas, Tex.; C. F. Harding, Lafayette, Ind.; J. P. Jollyman, San Francisco, Calif.; L. N. McClellan, Denver, Colo.; C. E. Rogers, Seattle, Wash.; I. M. Stein, Philadelphia, Pa.; A. C. Stevens, Schenectady, N. Y.; E. D. Wood, Louisville, Ky. *Directors*—C. R. Beardsley, Brooklyn, N. Y.; V. Bush, Cambridge, Mass.; F. M. Farmer, New York, N. Y.; N. E. Funk, Philadelphia, Pa.; H. B. Gear, Chicago, Ill.; F. E. Johnson, Columbia, Mo.; C. R. Jones, New York, N. Y.; W. B. Kouwenhoven, Baltimore, Md.; F. H. Lane, Chicago, Ill.; K. B. McEachron, Pittsfield, Mass.; C. A. Powel, East Pittsburgh, Pa.; R. W. Sorensen, Pasadena, Calif. *National Treasurer*—W. I. Slichter, New York, N. Y. *National Secretary*—H. H. Henline, New York, N. Y. (All members of the board were present, with the exception of Vice-President M. J. McHenry, of Toronto, Canada, who was absent on account of illness.)

Minutes were approved of a meeting of the board of directors held October 28, 1937, and of the executive committee on December 15, 1937.

Recommendations adopted by the board of examiners at meetings held December 16, 1937, and January 13, 1938, were presented and approved.

Upon the recommendation of the board of examiners, the following actions were taken: four applicants were transferred to the grade of Fellow; 16 applicants were transferred and 16 were elected to the grade of Member; 95 applicants were elected to the grade of Associate; 135 Students were enrolled.

The board of directors approved recommendations of the board of examiners for changes in the requirements governing admission to the grade of Fellow to limit admission to those who have been "in good standing in the grade of Member for a period of at least five years immediately preceding the date of application for Fellow grade," and are proposed by five Members or Fellows, with the exception of persons who have done "notable original work in electrical science," or who hold "in a principal national electrical engineering society of some other country membership of a grade for which the qualifications indicate a standing equivalent to that required for the grade of "Fellow" in the Institute. (This involves submission to the membership for vote this spring of amendments to section 4, article II, and section 10, article III, of the constitution. If adopted, the changes will go into effect about August 1, 1938.)

Disbursements in January, amounting to $22,214.67, were reported by the finance committee and approved; and a favorable report of Institute nances was given by the chairman of the committee.

In accordance with section 26 of the by-laws, a resolution was adopted determining the date and place of the 1938 annual meeting of the Institute, namely, June 20, in Washington, D. C.

Approval was given to the dates, May 18–20, 1938, of the previously authorized North Eastern District meeting to be held under the auspices of the Pitts field Section, at Lenox, Mass.

The following schedule of meetings in 1939 was adopted:

Winter convention	New York, N. Y.	January 23–27
Combined summer and Pacific Coast convention	San Francisco, Calif., or vicinity	Dates to be determined
North Eastern District meeting	Springfield, Mass.	May
South West District meeting	Houston, Texas	Spring
Middle Eastern District meeting	Location to be determined	October

The committee on co-ordination of Institute activities presented a report on a suggestion, which had been referred to the committee, made by A. M. MacCutcheon, in his president's address, that the Institute establish an additional committee, "a committee to investigate, review, and plan for 'the future of the AIEE.'" In brief, the report recommended, to take effect at the beginning of the next administrative year, August 1, 1938, the establishment of a committee named "The Committee on Planning and Co-ordination," to which would be assigned the responsibility for long-range planning of Institute activities, and which would also take over the responsibilities of the present committee on co-ordination of Institute activities; the committee to include the chairmen of the constitution and by-laws, finance, publication, Sections, standards, and technical program committees and the national secretary, and to appoint subcommittees including other members of the Institute as may be needed for specific aspects of planning. The board of directors accepted these recommendations in principle, and referred to the chairman of the committee on co-ordination of Institute activities and the national secretary the preparation of amendments to the by-laws to bring them in accord with this action.

Upon recommendation of the Edison Medal committee, the by-laws of that committee were amended to indicate the use of a letter ballot in connection with the December meeting of the committee for the award of the medal, a plan which has been followed since the establishment of the medal.

The by-laws of the Lamme Medal committee, in accordance with the committee's recommendations, were amended to provide for holding the meeting of the committee during the winter convention of the Institute, instead of in December as formerly.

A. B. Campbell was appointed a representative of the Institute on the committee on low voltage hazards of the National Safety Council for the remainder of the present administrative year, previous appointees having been unable to serve. The appointment of the Institute's two representatives on the council of the American Association for the Advancement of Science for the year 1938 was referred to the president with power.

Upon recommendation of the Sections committee, the board authorized the formation of a "Muscle Shoals Section" of the Institute, with territory including the following counties: Alabama counties—Lauderdale, Limestone, Colbert, Lawrence, Morgan, Franklin, Marion; Mississippi counties—Tishomingo, Itawamba, Alcorn, Prentiss, Lee; Tennessee counties—Hardin, Wayne, Lawrence, Giles, Lewis, Maury.

Also, the board authorized a change in name of the Atlanta Section to "Georgia Section," and the extension of its territory to include the entire state of Georgia.

The special committee on model registration law, appointed in May 1937 to draft a model law for the registration of engineers, which would be acceptable to electrical engineers, presented its report, including a draft of a model law and a statement of principles underlying the draft. The board adopted the statement of principles and authorized the special committee to proceed with the final stages in the prepara-

tion of the draft of the model law.

An invitation was presented and accepted to appoint two official delegates to the International Engineering Congress, Glasgow, Scotland, June 21–24, 1938, the national secretary to request two members in England to serve in this capacity.

Other matters were discussed, reference to which may be found in this or future issues of ELECTRICAL ENGINEERING.

Nominating Committee Announces Candidates

A complete official ticket of candidates for the Institute offices that will become vacant August 1, 1938, was selected by the national nominating committee at its meeting held at Institute headquarters, New York, January 25, 1938. This committee, in accordance with the constitution and by-laws, consists of 15, one selected by the executive committee of each of the ten geographical Districts, and five selected by the board of directors from its own membership.

The following members of the committee were present: C. R. Beardsley, Brooklyn, N. Y.; O. B. Blackwell, New York, N. Y.; Vannevar Bush, Cambridge, Mass.; F. B. Doolittle, Los Angeles, Calif.; Mark Eldredge, Memphis, Tenn.; J. H. Lampe, Baltimore, Md.; A. L. Maillard, Kansas City, Mo.; L. N. McClellan, Denver, Colo.; E. F. Pearson, Portland, Ore.; W. T. Ryan, Minneapolis, Minn., R. W. Sorensen, Pasadena, Calif.; A. C. Stevens, Schenectady, N. Y.; R. H. Tapscott, New York, N. Y.; J. M. Thomson, Toronto, Ont. (alternate for M. J. McHenry, Toronto); W. H. Timbie, Cambridge, Mass.; also, H. H. Henline, New York, N. Y., secretary of the committee.

The following is the list of official candidates selected by the committee:

FOR PRESIDENT

J. C. Parker, vice-president, Consolidated Edison Company of New York, Inc., New York, N. Y.

FOR VICE-PRESIDENTS

C. L. Dawes, associate professor of electrical engineering, Harvard University, Cambridge, Mass. (North Eastern District, number 1).

F. M. Farmer, vice-president and chief engineer, Electrical Testing Laboratories, New York, N. Y. (New York City District, number 3).

A. H. Lovell, professor of electrical engineering, assistant dean of college of engineering, University of Michigan, Ann Arbor (Great Lakes District, number 5).

F. C. Bolton, dean of the college, and dean of the school of engineering, Agricultural and Mechanical College of Texas, College Station (South West District, number 7).

L. R. Gamble, electrical engineer, Washington Water Power Company, Spokane (North West District, number 9).

FOR DIRECTORS

L. R. Mapes, chief engineer, Illinois Bell Telephone Company, Chicago, Ill.

H. S. Osborne, transmission engineer, American Telephone and Telegraph Company, New York, N. Y.

D. C. Prince, chief engineer, General Electric Company, Philadelphia, Pa.

FOR NATIONAL TREASURER

W. I. Slichter, professor of electrical engineering, head of department, Columbia University, New York, N. Y.

The constitution and by-laws of the Institute provide that the nominations made by the national nominating committee shall be published in the March issue of ELECTRICAL ENGINEERING. Provision is made for independent nominations as indicated in the following excerpts from the constitution and by-laws:

CONSTITUTION

Sec. 31. Independent nominations may be made by a petition of twenty-five (25) or more members sent to the National Secretary when and as provided in the By-Laws; such petitions for the nomination of Vice-Presidents shall be signed only by members within the District concerned.

BY-LAWS

Sec. 23. Petitions proposing the names of candidates as independent nominations for the various offices to be filled at the ensuing election, in accordance with Article VI, Section 31 (Constitution), must be received by the secretary of the National Nominating Committee not later than March twenty-fifth of each year, to be placed before that committee for the inclusion in the ballot of such candidates as are eligible.

On the ballot prepared by the National Nominating Committee in accordance with Article VI of the Constitution and sent by the National Secretary to all qualified voters during the first week in April of each year, the names of the candidates shall be grouped alphabetically under the name of the office for which each is a candidate.

(Signed) National Nominating Committee
by H. H. Henline, *Secretary*

BIOGRAPHICAL SKETCHES OF NOMINEES

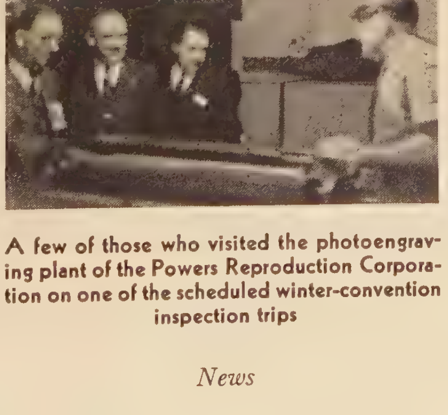
In order that those not personally acquainted with the nominees may know something of them and their qualifications for the Institute offices for which they have been nominated, brief biographical sketches are given in the "Personals" columns of this issue.

Triennial Montefiore Prize Papers Due Soon

Constituting interest on 150,000 Belgian francs, distributed triennially in international competition for the best original work presented on scientific advancement and progress in technical application of electricity in every field, the current George Montefiore Foundation prize award competition closes soon. The amount available for 1938 is 18,000 francs (about $600), and the closing date for entries is April 30, 1938.

The competition is limited to works presented during the three years that immediately precede the meeting of the jury of award. Papers either signed or anonymous are acceptable in typewritten manuscript or printed form, and must be written in either French or English and submitted in duplicate. By a four-fifths vote of the jury of award, composed of five Belgian and five other electrical engineers, one-third of the available amount may be awarded to a person who has not taken part in the competition, or to a work which without completely fitting the program, discloses a new idea that may have important developments in the electrical field.

The secretary-registrar of the foundation may be addressed at the headquarters of the Association des Ingénieurs Électriciens, 31 Rue Saint-Gilles, Liege, Belgium.



A few of those who visited the photoengraving plant of the Powers Reproduction Corporation on one of the scheduled winter-convention inspection trips

G. R. Metcalfe Dead; Former AIEE Editor

George Richmond Metcalfe, editor of the AIEE publications for 23 years, from 1910 until his retirement in 1933, died February 2, 1938. Mr. Metcalfe was born February 4, 1865, attended Brooklyn Polytechnic Institute, later entering Stevens Institute of Technology and graduating in electrical engineering in 1886. Following his graduation he served briefly as assistant to the chief engineer of the Edison United Manufacturing Company, New York, N. Y., after which he entered the drafting and testing department of the Daft Electric Company, New York, as a designer of switches used on the Daft system of railway control apparatus. In 1888 Mr. Metcalfe was associated with J. C. Henry, designing and building motors for the Rochester (N. Y.) Street Railway Company. Late in 1888 he became associated with the Sprague Electric Railway and Motor Company in the capacity of inspector and superintendent of construction. During 1890 and 1891 he served as electrical engineer with the Edison General Electric Company. Commissioned as inspector and superintendent of construction, he was in responsible charge of important work in building the Brandon (Manitoba) electric light and power station.

Later he became associated with C. O. Mailloux (A'84, M'84, F'12, past-president) before becoming associate editor of *Electricity* in 1892. From 1897 until 1899 Mr. Metcalfe was a member of the New York firm of Metcalfe and Moller, engaged in the maintenance and repair of electrical machinery, incandescent lamp fixtures, and associated electrical and mechanical equipment. In 1899 he turned again to editorial work, becoming technical editor of *Street Railway Review*, published in Chicago, Ill., where he remained until 1904. From 1904 until 1909 Mr. Metcalfe was editor of the *Technical World*, an editor of textbooks for the American School of Correspondence, editor of the publications department of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., and an associate of the publication department of the General Electric Company, Schenectady, N. Y.

At one time Mr. Metcalfe was a member of the AIEE, having been elected an Associate in 1892 and transferred to full membership in the same year, but subsequently resigned in 1898.

Reports of 13 Committee Meetings Held During the Winter Convention

During the recent AIEE winter convention, meetings of 13 general and technical committees and of six subcommittees of the Institute were held. Brief reports of the meetings of eight committees and five subcommittees are given here; others will be published as they become available. These reports have been prepared by the committee chairmen, or from notes supplied by them, except the report of the committee on Sections which was prepared by the committee secretary.

Committee on Automatic Stations

By O. J. Rotty, Chairman

A number of advance copies of the Proposed Standard for Automatic Stations as prepared by the American Standards Association were reviewed and the general subject of Standards was discussed. The proposed standard was prepared, with minor changes, from AIEE Standards No. 26 as revised by this committee several years ago, but not published.

Technical papers were discussed, one having been reviewed and approved and several others possibly being available in the near future.

Subcommittees are at work on "Telemetering and Supervisory Control" and on "Immediate Reclosing" and it was indicated that they were making satisfactory progress. It was decided to discontinue the subcommittee on battery charging because of lack of important or novel material on this subject.

Other subjects discussed were: effectiveness of protective devices in automatic stations, use of fuses in unattended stations, and forms for automatic stations; but it was the consensus of the committee that they did not warrant detailed study. The question of preparing a bibliography of articles pertaining to automatic stations was discussed, and it was decided to investigate the matter further.

Committee on Electric Welding

By W. E. Crawford, Chairman

The purpose of this meeting was to determine what steps may be taken, in so far as the AIEE is concerned, to clarify the situation with respect to the information that accompanies resistance-welding transformers. In connection with arc welding, it was thought that insufficient progress has been made to warrant consideration at this time.

The advisability of rating resistance-welding transformers as proposed in the paper "The Rating of Resistance Welding Transformers" by C. E. Heitman was discussed. (This paper was presented at the winter-convention session on electric welding, and is published in the Transactions section of this issue, pages 125–30.) It was the consensus of opinion that this standardization preliminary work should be followed up, and that the resistance-welding-machine builders should be contacted to try to obtain a common ground of workable agreement in this field. Steps are to be taken in this regard.

Committee on Electrochemistry and Electrometallurgy

By F. O. Schnure, Chairman

Activities for future sessions were discussed at the meeting of this committee, at which eight members were present. It was agreed tentatively to promote a technical conference for the AIEE 1938 summer convention on "power requirements and load characteristics of electrochemical and electrometallurgical industries." For the 1939 winter convention a conference was proposed on "atmospheres for electrometallurgical furnaces."

Committee on Power Generation

By G. M. Armbrust, Chairman

At the meeting of this committee, it was decided that the most important subject before the committee at this time is "modernization of switch-house and terminal facilities." It was decided to prepare material for a round-table discussion at the AIEE 1938 summer convention, and to proceed with the preparation of papers for a symposium on this subject to be presented at the 1939 winter convention.

Committee on Production and Application of Light

By Robin Beach, Chairman

Main discussion at this meeting centered around the make-up of the program for a session of this committee at the Institute's 1938 summer convention.

Committee on Protective Devices

By J. P. McKearin, Chairman

The subcommittee chairmen reported on the progress of their various projects.

The text of the revised Standards for Oil Circuit Breakers (Number 19) as approved at the November 5, 1937, meeting of the committee was reviewed. Some minor revisions in the text are required before these standards are to be submitted. A revision of the Standards for Air Circuit Breakers (Number 20) is being considered. The preparation of Standards for Fuses Above 600 Volts (Number 25) is to be resumed after completion of the oil circuit breaker standards. The preparation of standards for grounding resistors and reactors is still in progress.

The report on "Test and Application of Lightning Arresters" has been recommended for publication. The results of methods of testing arresters, as recommended in this report, are being studied. Two additional lightning arrester reports are being prepared. These are on "Testing Procedure for Station Type Arresters," and "The Characteristics of Station Type Arresters and Line Type Arresters Above 15 Kv." An investigation is being made of protector tubes, and a memorandum is to be prepared. Another investigation is being made of specific lightning protection problems, such as the protection of synchronous machines, constant-current transformers, induction regulators, oil switches in the open position, instrument transformers, and customers' equipment. A previous report on this subject is to be revised and enlarged.

Investigations are being made of high-speed tripping and reclosing, simplification of relay design and application, standardization of current transformers for relay purposes, distribution-circuit protection, and bus protection.

Additional projects were assigned to appropriate subcommittees. Lightning Arrester Standards (Number 28) are to be reviewed and a study made to determine the need and requirements for a revision of these standards. The question of preparing standards for protector tubes is to be investigated, and as an initial step proposed standard definitions and nomenclature are to be prepared. The requirements for standards for metal-enclosed switchgear are to be studied, and a preliminary report submitted. An investigation is to be made to determine the need for a revision of the "Relay Handbook."

Some of the work being handled comes under the joint scope of this and other committees, both within and without the AIEE. This type of work is being handled jointly with the other committees.

There was a discussion of the need for co-ordination of dielectric tests which differ for protective devices and other types of apparatus, such as the wet dielectric tests specified for oil circuit breakers and for transformers, and the question of impulse tests for oil circuit breakers. It was thought that steps should be taken to bring about a more suitable co-ordination in the dielectric specifications of various types of apparatus.

Definite plans were made for participation by the committee at the 1938 AIEE summer convention, and tentative plans were discussed for the presentation of papers at the 1938 Pacific Coast convention and future District meetings.

Committee on Sections

By H. H. Race, Secretary

Section "self-analysis" studies that have been under way for some months under sponsorship of this committee was the first item on the agenda of this meeting, with W. H. Timbie, chairman of the committee, presiding. A final report, prepared by C. M. Foust (A'22, M'31) past-chairman of the AIEE Schenectady, Section, was presented by Secretary Race. This report was approved for distribution to the AIEE Sections; full text appears elsewhere in this issue.

"Licensing and status of the engineer" was the next topic of discussion, with the suggestion that the subject be actively considered in local Section meetings. After considerable general discussion, it was voted that Chairman Timbie should prepare as comprehensive a survey on this

subject as is possible, in collaboration with Director C. R. Beardsley, and National Secretary H. H. Henline, and send copies to the Sections.

M. S. Coover (A'16, M'32) Iowa State College, Ames, presented a report summarizing the present practice of various Sections regarding local members. The general conclusion of this report, corroborated by the discussion, is that: "The problem of local membership should rest with the individual Section and should be handled according to its best judgment and the conditions in the community."

A number of Sections sporadically have attempted to place in the hands of high-school teachers and students material to help the latter determine whether they were fitted for, and interested in, obtaining college training in engineering. Apparently the best available material for such use is contained in the pamphlet "Engineering—A Career, A Culture," which was prepared under the auspices of the Engineering Foundation. Past-President C. F. Scott reported that about 30,000 copies of this pamphlet are available and may be obtained from the Engineers' Council for Professional Development at $5 per hundred.

No action was taken on this subject, but Chairman Timbie urged each Section to co-operate actively with other engineering societies in its locality to disseminate such materials in high schools giving college entrance training.

Committee on Safety

By Wills Maclachlan, Chairman

The chairman reported that a number of papers dealing with electric shock, artificial respiration, and general matters of accident prevention are being presented, on the recommendation of the committee, at meetings of AIEE Sections and Student Branches. At the suggestion of the committee, some 52 universities and colleges have arranged to have artificial respiration taught to their senior students. To assist this, the committee has considered the preparation of a booklet on artificial respiration.

It was decided to hold a meeting of the committee at the AIEE 1938 summer convention where the question of electric fences would be thoroughly discussed. Invitations to attend this meeting will be made to some outside of the Institute membership who are interested in this problem. An endeavor is being made to have a paper presented at one of the meetings of the Institute dealing with safe practices in college laboratories.

Subcommittee No. 1 of Sectional Committee on Electrical Definitions

By H. L. Curtis, Chairman

This meeting was concerned with the revision of the "general" definitions contained in the previously published report (AIEE No. 2) of the sectional committee on electrical definitions (*C*42). Many comments have been received and so far as time permitted all of these were given consideration.

The committee is faced with the necessity of acting arbitrarily in regard to many of the suggestions received. In particular it must decide whether a given definition should or should not be included, and in this respect the committee has found it necessary to exercise careful judgment.

Lightning Arrester Subcommittee

By J. R. North, Chairman

At this meeting, 13 out of 16 members were present, with two guests—making a total of 15. This year the work of the subcommittee has been divided into several projects, each with a subject sponsor. This arrangement is the same as used in previous years and greatly facilitates the effective handling of committee work by correspondence. The work of each of the projects was discussed as follows:

1. *Test Procedure for Distribution Arresters.* Herman Halperin reported that his group was continuing the study of field experiences with the test methods as proposed in a committee report of last year.

2. *Testing Procedure for Station Type Arresters.* H. W. Collins presented a draft of a memorandum outlining proposed procedure for testing station type arresters in the field. This memorandum included a description of the surge generators required and the necessary testing procedure based upon the experience of the Detroit Edison Company. After comments have been obtained on further field experience this procedure will be made available to all Institute members in report form.

3. *Characteristics of Station-Type and High-Voltage Arresters.* K. B. McEachron reported on progress made in effecting a general agreement among the manufacturers regarding the basis for performance characteristics at uniform values of discharge currents and rates of currents and voltage application. It is hoped to have this data available in time for presentation as a subcommittee report at the 1938 AIEE summer convention.

4. *Protector Tubes.* The protective devices committee requested the lightning arrester subcommittee to assemble data pertaining to the standardization of terminology and such information as is available regarding the application of protector tubes. J. J. Torok, the sponsor of this group, was unable to be present, but it is hoped that definite progress will be made on this work.

5. *Specific Protection Problems.* I. W. Gross reported on the status of this work which includes the review of a memorandum on the same subject prepared last year, together with the assembling of further information covering protection practices on synchronous machines, instrument transformers, customer equipment, etc.

There was considerable discussion concerning the desirability of reviewing at this time the Standards for Lightning Arresters (Number 28), especially that portion pertaining to test procedure and including the consideration of necessity for increasing the magnitude of discharged current, rate of voltage application, rate of current rise, etc. It was decided to create a new project group to survey the field and report on improvements necessary in the standards. This will include consideration of the new method of testing with infinite rate of current rise as proposed by H. L. Rorden.

The following papers are being sponsored for the summer convention:

Lighting Protection of 22-Kv Substation, by E. R. Whitehead.

Performance Characteristics of Station Type Arresters, report of the lightning arrester subcommittee.

In addition to these, the memorandum prepared last year entitled "Testing and Application of Lightning Arresters" has been modified and recently submitted to Institute headquarters for publication in pamphlet form with suitable announcement in Electrical Engineering, as recommended by the protective devices committee at its last meeting.

Subcommittee on Revision of AIEE Standard No. 4

By E. J. Rutan, Chairman

The project being carried out by this subcommittee represents part of the program of the AIEE committee on instruments and measurements. The meeting was called to consider the progress reports of the several sections which had been organized to consider new material for scope, method of measurement, sphere-gap revision, and testing equipment. The scope is being revised so as to include high-voltage d-c and

This group visited the meter works of the Westinghouse Electric and Manufacturing Company at Newark, N. J., on one of the scheduled winter-convention inspection trips

surge potentials which were not provided for in the previous standard. The section on method of measurement will include standard methods for a-c and d-c high-voltage and surge potentials. The methods for surge potentials may now be secured from AIEE headquarters as a progress report. In addition, a number of approved methods will be listed and briefly discussed from the standpoint of limitation and application.

The new settings for sphere-gap standards already have been approved and are available on application to AIEE headquarters. The material, however, concerning details of gap construction is being revised and was actively discussed at this meeting.

The subcommittee on testing equipment and arrangement proposes to introduce considerable information in regard to the details of the equipment and precautions for use in the field. It is hoped to have this section sufficiently detailed so that it represents the cumulated experience to date of investigators in the field of high-voltage testing.

The committee will welcome suggestions from anyone active in the field of high-voltage testing, particularly regarding items which they have thought are not adequately covered in the present standard.

Sectional Committee on Metal-Tank Mercury-Arc Rectifiers

By E. L. Moreland, Chairman

This meeting was held for the purpose of considering the standards for mercury-arc-rectifier equipment for traction purposes adopted by advisory committee No. 9 of the International Electrotechnical Commission, and recommended as an international standard. With a few minor exceptions, the IEC proposals were considered to be satisfactory by the sectional committee.

Subcommittee on Wave Form

By A. C. Seletzky, Chairman

At this meeting, which was attended by all members of the subcommittee, the effects of deviation of wave form from a pure sinusoid were considered from all possible angles. A report is being prepared for submission to the parent committee on instruments and measurements. This report will contain a recommendation for maximum permissible deviation of wave form in dielectric power-factor measurements.

New Index to ASTM Standards. The latest index to standards and tentative standards of the American Society for Testing Materials lists 511 standards and 312 tentative standards in effect as of January 1, 1938. All items are listed in the index under appropriate key words, according to the particular subjects they cover. As a convenience, a list of the specifications and tests in numeric sequence of their serial designations is given. Copies of this publication are furnished without charge on written request to ASTM headquarters, 260 South Broad Street, Philadelphia, Pa.

Institute's Major Objectives Reaffirmed in Section "Self-Analysis"

Major objectives of the AIEE, as stipulated in its Constitution, were reaffirmed in the results of a survey recently completed by the Sections committee. Final report, based upon "self-analyses" by 32 of the Institute's 64 Sections and prepared by C. M. Foust (chairman of the AIEE Schenectady Section 1936–37) was approved at a meeting of the Sections committee held during the recent winter convention. Full text is presented here.

A program of self-examination has been in progress throughout recent months in the local Sections of the AIEE. Assisted by the Sections committee, each local group has asked itself four questions:

What is our aim or objective?

Through what activities are we endeavoring to accomplish this objective?

What results have we obtained during the last five years?

How can we change our activities to obtain better results?

Eighteen Sections had completed their self-analysis and reported in time to be included in the "Summary Self-Analysis" distributed at the delegates meeting at the Milwaukee summer convention in 1937. Although not reporting in time to be included in the printed summary, seven additional Sections had sent in results by meeting time and these were included in the summing-up discussions. Electrical Engineering for August 1937 reported the experiment in self-analysis to date on page 1046. During the succeeding months seven more Sections reported, bringing the total of groups to complete the work up to 32. The complete answers to the four questions can now be summarized directly from the Section reports.

Our major aim or objective as set forth in our Constitution is reaffirmed:

The advancement of the theory and practice of electrical engineering and of the allied arts and sciences and the maintenance of a high professional standing among its members.

This was on its adoption, and still is, our expression of an all-time faith in a chosen work. It is the agreed-upon goal of our integrated thinking and acting and therefore the criterion by which we test efforts.

The Sections agreed that in furthering this major objective we are also called upon continuously to recognize minor aims, which are used to guide us in conducting our daily affairs. A summary of the most frequently mentioned of these may be stated briefly as follows:

To provide opportunities for students and workers in the engineering field to become acquainted, to exchange ideas, to keep up-to-date technically, and to stimulate group activities.

Now another type of minor aim, expressed in many ways, and apparently not yet clearly and definitely developed has to do with the relation of the Section to the social group of which it is a part. Almost every Section analysis included some comment indicating interest in this question. Expressed variously it ran:

To inform the public—to promote civic interest—to discuss economics—to co-operate in promoting education—to stimulate the activity of engineers in community and civic interests—etc.

Here we note a real desire on the part of our membership to carry over into social affairs in general some of the effectiveness which has marked our activities in technical fields.

Through what activities are we endeavoring to accomplish our objectives? On this question the Sections report that some six activities are widely used:

1. Technical meetings with special speakers.
2. Combined business-social meetings.
3. Prize technical papers or technical-paper competitions.
4. Combined Section and Student Branch meetings.
5. Technical discussion groups.
6. Co-operation with other engineering societies.

It is fair to say that these six preferred activities have contributed the major portion of the success of the local Sections. True, each is worked out in detail somewhat differently for particular Sections, nevertheless classification under the above headings was obvious. In the main these are the activities which have been thoroughly tested and found successful. The first five contribute directly toward our major objective and the first of our minor objectives. This means that our Section activities are directed inwardly, concentrating effectively on the inner life of our body of electrical workers. Of course, it is necessary to observe quickly that through acquaintances and exchange of ideas made possible by these activities other outward or social aims such as summarized in the second of our minor aims are accomplished indirectly. Also co-operation with other engineering societies (activity 6) which is now quite general and developing steadily, aids in reducing the isolation of the electrical groups.

The Section reports show a feeling of general confidence and satisfaction in the results accomplished. True there are occasionally expressed regrets, that meetings are not better attended, especially in those Sections where membership is large and attendance is frequently diverted by other interests. On this point the success of some of the smaller Sections working under the disadvantage of great distances cannot be noted but with great pleasure.

How can we change our activities to obtain better results? As might be anticipated, answers to this question were everywhere uncertain. Many Sections reported plans to inaugurate one of the activities included in the list of the six now commonly used and described above. These Sections will undoubtedly be gratified to find that good results are obtained. In other cases activities which have been attempted previously with only occasional success are being given attention. Here a word of caution is justified as nothing so deadens the

spirit of a group as a number of such failures.

The members of the Sections committee have a recommendation to pass on to the Sections in connection with new activities. It is this: In expanding the work of a Section, search first for new activities among those generally found successful in the other Sections. Embark on new work which is as yet untried in other Sections only after a very careful study of the possibilities of success. Consult the reports of the Sections committee and request information in advance. Particularly this recommendation applies to activities of technical and organizational nature.

Principally through such groups as the American Engineering Council and the Engineers' Council for Professional Development, the AIEE finds at least partial facilities for maintaining contacts in general social problems. For the local Sections, however, only very limited facilities are available through which can be worked out an engineers' analysis of local, social, or civic problems for the guidance of the group as a whole or its individual members. This is the point in mind which gives rise to our second minor aim or social objective and here it would seem that our local Section experience provides us with little guidance. *However, this problem is quite likely the outstanding one of our time.* We are not at loss as to our objectives in connection with it. We want to preserve, protect, regain, and build such a social environment as will permit us to work for "the advancement of the theory and practice of electrical engineering and of the allied arts and sciences and the maintenance of a high professional standard among our members." Many local Sections want to do something about this. In so far as such activities are constructive, this work is well within the scope of our objectives. In bringing to social problems the engineer's way of thinking, three aims are realized. First, these problems invariably have technical phases which lend themselves to correct solutions only through objective treatment. To this extent, therefore, science is advanced. Second, a high professional standard among engineers is realized only when co-operation and not isolation is the program. Third, the privilege of pursuance of our major objective requires a vigilant attitude toward the changing social structure, *lest we find ourselves within an environment which considers our activities and aims of minor or remote importance.*

The recommendation of the Sections committee at this time is therefore that the problem of ways and means through which local Sections can effectively co-operate on local problems be given critical attention. The response of your local executive committee to requests for such activities should be the setting up of a committee of those interested to examine possible courses of action in this field. It is recommended that the co-operation of all engineers and engineering groups be invited, since effectiveness will not be realized unless common aims are recognized. Again the Sections committee wishes to voice a word of caution concerning the futility of taking positions on questions which do not have technical aspects. If a portion of the membership wishes to participate in study of discussion groups in economics, social, or civic questions sufficient to make for success, such an activity is warranted. It is, however, well to emphasize that the major aim is discussion and personal education. If such activities lead to essentially unanimous opinions regarding specific problems, local groups may find means for making valuable contribution toward the solution of local problems having engineering significance, and engineers' reactions to social problems of a wider scope can be expressed through the Founder Societies and the Engineering Foundation.

In summarizing, the Sections committee calls attention to the following recommendations:

1. In the quest for expanded local Section activities examine first those already found to be generally successful in other Sections.

2. Embark on new types of activities only after careful study to avoid, if possible, discouragement resulting from unsuccessful attempts.

3. Recognize the inward and technical nature of most of our activities; and where membership requests are made for the consideration of local, economic, or social problems take active but careful steps to build up sound engineering treatment of these problems.

4. Recognize that a high professional standard for electrical engineers implies not isolation but co-operation with other organizations, technical and nontechnical.

Eta Kappa Nu Honors Young Engineers

At a meeting on January 28, 1938, in New York, N. Y., the Eta Kappa Nu Association presented to C. G. Suits of the General Electric Company, Schenectady, N. Y., its award for the 1937 Eta Kappa Nu recognition of "outstanding young electrical engineers." Mr. Suits received a small bronze bowl, a replica of the larger one on display at AIEE headquarters, and upon which his name now is engraved as the second winner of the award. The first award was made last year to F. M. Starr (A'30) of the same company.

Certificates of honorable mention were presented to L. L. Carter (A'29, M'35), P. T. Farnsworth, and C. A. Faust (A'35). Vladimir Karapetoff (A'03, F'12, Life Member) professor of electrical engineering at Cornell University, entertained those present by his skill as a pianist. Vannevar Bush (A'15, M'24, Lamme Medalist 1935) vice-president and dean of engineering at Massachusetts Institute of Technology, was the principal speaker of the evening. His address was entitled "The Young Engineer and His Government."

Gano Dunn (A'91, F'12, Life Member, past-president, Edison Medalist '37) spoke briefly, commending the recognition plan and expressing the thought that it may usher in a new aristocracy of personal merit which will succeed the aristocracy of wealth which now seems to be passing. Other members of the AIEE taking part in the program were Morris Buck (A'05, F'23), toastmaster, C. F. Harding (A'06, F'14, vice-president), O. W. Eshbach (A'17, M'30), and R. I. Wilkinson (A'35).

Mr. Suits presented an address on the subject "Studying Arcs by Photography." Motion pictures in color were shown of arcs between electrodes in several different gases at pressures as high as 100 atmospheres. The pictures were taken with a special camera at a speed of 1,000 per second.

At the presentation of the Eta Kappa Nu Awards as "outstanding young electrical engineers," left to right: L. L. Carter (A'29, M'35) 1937 honorable mention; C. G. Suits, 1937 winner; Morris Buck (A'05, F'23) president, Eta Kappa Nu Association; P. T. Farnsworth and C. A. Faust (A'35) 1937 honorable mentions

International Communication Conference Held in Egypt

For the purpose of considering various phases of telephone, telegraph, and radio operations on an international basis, an international conference is scheduled to be under way in Cairo, Egypt, as this issue of ELECTRICAL ENGINEERING goes to press. Among those present at the conference representing the Bell Telephone Laboratories are its president, F. B. Jewett (A'03, F'12, past-president), Lloyd Espenschied (A'18, F'30) of New York, and L. F. Morehouse (M'16, F'20) and G. G. Barney of London; representing the American Telephone and Telegraph Company, C. O. Bickelhaupt (M'22, F'28, past vice-president) and F. M. Ryan (A'19, M'26) of New York.

Among the important matters scheduled for consideration is that of short-wave broadcasting, a subject that has become of major importance in the political strategy

of many nations. The delegates were asked to find a way of alloting wider frequency bands for short-wave broadcasting without seriously curtailing allocations for other purposes. The allocation of frequencies for aviation radio also presents numerous problems, particularly with respect to Europe. In so far as wire communication is concerned, an outstanding question relates to telegraph tariffs and the conventions underlying word counts.

Like those that have preceded it at intervals during the past 60 years, the fundamental objective of the present meeting is to establish binding agreements among the sovereign powers that will facilitate communication development.

Marine Radiotelephone Service. Ship-to-shore radiotelephone service, linking the SS "Washington" of the United States Line with 93 per cent of the world's 35,000,000 telephone subscribers, recently was initiated. The SS "Manhattan" also is being equipped for this service. Through a telephone handset, calls between the vessels and either the United States or Europe may be made throughout the entire trans-Atlantic voyage. The transmitter used aboard ship is equipped with an automatic frequency-shifting mechanism through which a telephone dial immediately transfers the radio transmitter to any one of ten preselected radio telephone channels. The radio receiver is designed so that watch may be kept simultaneously on three different shore-station frequencies.

Secretary of Canadian Association Dead. Captain Edward A. Wheatley, registrar and secretary-treasurer of the Association of Professional Engineers of British Columbia, died February 2, 1938, at Vancouver. Captain Wheatley was born in London, England, where he received his early engineering training. He went to Canada in 1910, where he worked at his profession until the World War. Enlisting in 1914, he served first in King Edward's Horse, and finally in the Royal Engineers. In 1918 he was seriously wounded and was discharged from active service with the rank of captain. Following the war, Captain Wheatley returned to British Columbia and in 1921 was appointed registrar and secretary-treasurer of the Association of Professional Engineers of British Columbia. He was a member of the Engineering Institute of Canada and the Canadian Institute of Mining and Metallurgy.

World Power Conference to Be Held in Vienna

Preparations are now under way for the World Power Conference which will be held in Vienna, Austria, from August 25 to September 2, 1938, according to a report to the Bureau of Foreign and Domestic Commerce from the office of the American commercial attache, Vienna. Subjects to be discussed at the conference include electric-power requirements for agriculture, trade, the household public utilities, and electric railways, the report states.

O. C. Merrill (M'24) first vice-president of the international executive council of the World Power Conference, with offices in Washington, D. C., is in charge of arrangements for United States' participation in this event.

Future Meetings of Other Societies

American Association for the Advancement of Science. Summer meeting, June, Ottawa, Can.

American Chemical Society. Semiannual meeting, April 18–21, Dallas, Tex.

American Institute of Physics. Symposium on physics in the automotive industry, March 14–15, Ann Arbor, Mich.

American Railway Engineering Association. March 15–17, Chicago, Ill.

American Society for Metals. Western Metal Congress, week of March 21, Los Angeles, Calif.

American Society for Testing Materials. 1938 regional meeting, March 7–11, Rochester, N. Y.

Annual meeting, June 27–July 1, Atlantic City, N. J.

American Society of Civil Engineers. Annual spring meeting, April 20–22, Jacksonville, Fla.

American Society of Mechanical Engineers. National spring meeting, March 23–25, Los Angeles, Calif.

Semiannual meeting, June 20–24, St. Louis, Mo.

Association of Iron and Steel Engineers. Annual spring conference, April 28–29, Baltimore, Md.

Canadian Electrical Association. Annual convention, June 22–24, Seigniory Club, Province of Quebec, Can.

Edison Electric Institute. Engineering committees, May 2–5, Chicago, Ill.

Annual convention, June 7–9, Atlantic City, N. J.

International Conference of Naval Architects and Marine Engineers. June 16–18, London, England.

International Engineering Congress. June 21–24, Glasgow, Scotland.

Midwest Power Conference. April 13–15, Chicago, Ill.

National Electrical and Radio Exposition. April 20–30. New York, N Y.

National Fire Protection Association. May 9–13, Atlantic City, N. J.

Northwest Electric Light and Power Association. Annual meeting, April 20–23, Vancouver, B. C.

Society of Automotive Engineers. National passenger car meeting, March 28–30, Detroit, Mich.

Annual meeting, June 12–17, White Sulphur Springs, W. Va.

Society of Chemical Industry. Annual meeting, June 20–22, Ottawa, Can.

Ice Damages Niagara Power Plant

AN UNPRECEDENTED flow of ice from Lake Erie formed an accumulation in the Maid of the Mist Pool of the Niagara River on January 26, 1938, raising the water at the Hydro-Electric Power Commission's Ontario power plant, which is located on the Canadian shore about 800 feet downstream from the crest of the Horseshoe Falls, to a height of about 45 feet above the normal tailwater level. The ice jam and high water resulted in the flooding of the plant to a depth up to the crane rails, completely submerging all the units. After the river level had subsided and the water drained from the building, it was found that eight of the units were completely covered with ice, the volume of which is estimated to be approximately 7,000 tons. The plant contains 15 horizontal-shaft, twin-turbine generating units with a total capacity of 175,000 horsepower.

Letters to the Editor

CONTRIBUTIONS to these columns are invited from Institute members and subscribers. They should be concise and may deal with technical papers, articles published in previous issues, or other subjects of some general interest and professional importance. ELECTRICAL ENGINEERING will endeavor to publish as many letters as possible, but of necessity reserves the right to publish them in whole or in part, or reject them entirely.

ALL letters submitted for consideration should be the original typewritten copy, double spaced. Any illustrations submitted should be in duplicate, one copy to be an inked drawing but without lettering, and other to be lettered. Captions should be furnished for all illustrations.

STATEMENTS in these letters are expressly understood to be made by the writers; publication here in no wise constitutes endorsement or recognition by the American Institute of Electrical Engineers.

What Is Tensor Analysis?

To the Editor:

In his recent letter [*EE, Feb. '38, p. 83*] Doctor J. Slepian raises several interesting points concerning the first part of my article "What Is Tensor Analysis?" Since they indicate a misapprehension of my meaning on the part of Doctor Slepian, I welcome an opportunity to discuss his letter in some detail.

At the beginning of his letter Doctor Slepian states that "Doctor Banesh Hoffmann makes the 'parallelogram law of addition' the fundamental property which distinguishes vectors from other objects describable in terms of components," and bases almost all his objections on this premise. I cannot see that the paragraph immediately following figure 1 of the article can bear any other interpretation than that the parallelogram law of addition distinguishes vectors from other objects *having magnitude and direction*, which is quite a different thing. Nor can I find any other place in the first part of my article which could reasonably signify what Doctor Slepian says I wrote. Since I did not write it, and since Doctor Slepian confines his more important critical remarks to what I did not write, perhaps I may justly feel flattered by his implied endorsement of my article.

This endorsement, in fact, goes quite deep, for toward the end of his letter Doctor Slepian points out that "Authorities such as Levi-Civita and Weyl make the equations 1.14 and 1.16 fundamental as defining tensors and contravariant vectors," and it so happens that I do too. That this is so is evident not only from the remarks below equation 1.23, and those above equation 1.38, but also from the whole structure of my article. For it is clear that the long discussion of vectors from the nontensorial point of view on page 5 was more or less parenthetical. It comes *after* equation 1.14, and was included in order to show that the tensorial approach, which in equation 1.14 looks so strange and remote, is in fact entirely consistent with the much more familiar approach of the ordinary vector calculus. The tensorial point of view is the preferable one. It is more general than the vector calculus one, even for isolated vectors, in that it does not require the existence of a metric, whereas mention of the word *magnitude* makes a metric essential. When general co-ordinates and fields are under consideration, the ordinary vectorial approach soon reveals itself as seriously inadequate.

In view of what I have explained in the first paragraph of this letter, the remarks in Doctor Slepian's third paragraph have no bearing upon my article. Nevertheless the point there raised is an interesting one and a discussion of it here will probably not be out of place. Doctor Slepian mentions entities of the type

$$\left(\frac{\partial^2 u}{\partial x_1^2}, \frac{\partial^2 u}{\partial x_2^2}\right)$$

which do not transform like vectors although they can be given a parallelogram law of addition. From the point of view of the ordinary vector calculus, the essential reason why they are not vectors is that they do not possess magnitude. It would seem a simple matter to define a magnitude for them, just as it was to define their parallelogram law. But the catch is that the magnitude must be consistent with the particular parallelogram law bestowed on them. The parallelogram law is intimately related to the definition of components; the magnitude must be defined in terms of these components; and the essential thing about the magnitude of a vector is that it must be the same for all possible sets of components. Does such a magnitude exist for Doctor Slepian's

$$\left(\frac{\partial^2 u}{\partial x_1^2}, \frac{\partial^2 u}{\partial x_2^2}\right)?$$

In the second paragraph of his letter Doctor Slepian points out what looks like a serious *non sequitur* in my argument. I state that the equations of transformation of a contravariant vector 1.16 follow at once from the parallelogram law of addition. He aptly remarks that covariant vectors also have a parallelogram law. How then can they transform so very differently from contravariant vectors? For the resolution of this paradox I can hardly do better than refer to one of Doctor Slepian's own favorite authorities, Professor Weyl. In the first chapter of Weyl's "The Theory of Groups and Quantum Mechanics" will be found a detailed discussion of the *dual vector space*. In the passage of my article at present in question the phrase "parallelogram law of addition" clearly refers to figure 1, in which vectors are represented by arrows. If a vector is represented by an arrow it will transform according to the contravariant law 1.16. To be able to represent a covariant vector by an arrow we must go over to the dual space, in which contravariant and covariant have interchanged roles. In this space a covariant vector does transform according to the law 1.16 as applied to the dual space, and it is the contravariant vector which now seems to be the outcast.

There remains for discussion only the objection raised in the very first paragraph of Doctor Slepian's letter; an objection which, I feel sure, was not intended to be taken too seriously. The situation is as follows:

In defining a vector in the standard vector calculus manner, I mentioned the vector law of addition. This, of course, implied the existence of more than one vector.

Doctor Slepian at once argues that I have therefore implied that a single vector cannot be a vector.

Let us suppose that, instead of defining a vector, I had been defining *homo sapiens*. I should then have had to mention the human "law of multiplication," and thus bring in parents and children.

To be consistent, Doctor Slepian ought immediately to insist I had implied that a single man cannot be a man.

Does he seriously imagine that I, a bachelor, would imply any such thing?

Very truly yours,

B. HOFFMANN

(Instructor in Mathematics, Queens College, Flushing, N. Y.)

Registration of Engineers

To the Editor:

In all of my 18 years of affiliation with the AIEE I have never witnessed such an unwarranted and unprofessional attack on members of our profession as appears in a "Letter to the Editor" by Louis S. Leavitt (A'24, M'28) published in the January 1938 issue, page 42.

His charge that the engineering examining boards are composed of politicians and that the whole thing may degenerate to a political racket "is not" substantiated by the facts, which are available to anyone; even to those whose sincerity of purpose is questionable, when tainted with such violent abuse of their fellow practitioners.

I have yet to witness in the legal or medical profession such an unethical attack unchallenged.

The members of these examining boards are members of our profession serving with little or no compensation at great personal sacrifice without fear or favor and need no defense other than their unimpeachable records.

Sincerely yours,

WILLARD S. CONLON (A'20, M'28)

(Executive Secretary, National Society of Professional Engineers, Washington, D. C.)

A Review of Radio Interference Investigation

To the Editor:

I have noted with considerable interest an article in the October issue of ELECTRICAL ENGINEERING, pages 1248–52, entitled "A Review of Radio Interference Investigation" by F. E. Sanford and Willard Weise.

This article is very well written, but I wish to take exception to some of the statements contained therein.

The authors have been exceedingly complimentary to the manufacturers of radio sets. On page 1248 in the third paragraph, they speak of the so-called self-contained, compact receivers without special aerials. Such receivers are the cause of a great deal of grief in connection with radio complaints received by the power companies, and it would seem that the manufacturers of radios would place more stress upon the manufacture and the selling of proper aerials than they do at the present time.

On page 1251, the second column and next to the last paragraph, they state that the manufacturers have devoted a great deal of research and experimental work to proper shielding from outside influences. At the present time I know of almost no radio set that is manufactured for general use of broadcast reception that is shielded from outside noise. The ordinary home set may be connected to the 110-volt supply leads, and without any aerial play any number of stations, as well as all the noise in the vicinity. If the radio set were properly shielded according to the findings of the research and experimental departments, it would not be possible to play any stations or hear any noise as long as the aerial and ground posts of the radio set had nothing connected to them. This is one of the most troublesome parts of radio interference, and as far as I have been able to learn, the manufacturers have done almost nothing about it. In the majority of makes of radios, the 110-volt leads are brought to the back of the chassis, and one wire crosses through the chassis to the front where the on-and-off switch is located, thus exposing all of the chassis wiring to whatever noise may be traveling on the 110-volt wires. The pickup of noise thus created should be eliminated.

I do not wish to detract from the good article that the authors have written, but I believe that these particular points should be brought out in print in order that the manufacturers of radio sets will be made thoroughly aware of the conditions which they are imposing upon the electrical operating companies. In that connection, on page 1252, the second paragraph, a fourth party should be added to the list of those requiring co-operation, and that fourth party should be the radio set manufacturer.

Yours very truly,

H. N. Kalb

(Pacific Gas and Electric Company, San Francisco, Calif.)

Personal Items

J. C. Parker Nominated for Presidency

John Castlereah Parker (A'04, M'09, F'12, past vice-president) vice-president of the Consolidated Edison Company of New York, Inc., New York, N. Y., has been nominated for the presidency of the AIEE for the 1938–39 term. Doctor Parker was born April 15, 1879. In 1901 he was graduated with the degree of bachelor of science in mechanical engineering at the University of Michigan, and received the degree of master of arts there in 1902 for advanced work in mathematics, physics, and structural engineering. He received the degree of electrical engineer from the University of Michigan in 1904, and in 1935 he was honored by the award of the degree of bachelor of engineering from Stevens Institute of Technology. At the end of his graduate studies he was employed as a tester in the works of the General Electric Company at Schenectady, N. Y., and during the academic year 1903–04 was an instructor at Union College under Doctor C. P. Steinmetz (A'90, M'91, F'12, past-president). Returning to industrial work in 1904, he spent a year as assistant to the engineer in charge of the construction and design of the Ontario Power Company's plant at Niagara Falls. In 1905, on the completion of the first section of the Ontario Power Company's plant, Doctor Parker went to Buffalo as assistant to the vice-president and chief engineer of the construction company building the lines of the Niagara, Lockport, and Ontario Power Company from Niagara Falls to Syracuse, N. Y., said to be the first 60,000-volt transmission line in the United States. In 1905, with the introduction of Niagara power in Rochester, N. Y., he moved to that city and soon became mechanical and electrical engineer of the Rochester Railway and Light Company, in charge of the hydraulic, structural, steam, and electrical engineering in construction of that company's electric properties. In 1915 the University of Michigan appointed Doctor Parker professor and head of the department of electrical engineering, from which position he resigned in 1922 to become electrical engineer of the Brooklyn Edison Company, Inc. Four years later he became vice-president in charge of engineering, and in 1932 was elected president of that organization. Since 1936 he has been vice-president of the Consolidated Edison Company of New York, Inc. Doctor Parker holds many executive and advisory positions outside the Consolidated Edison Company. He is a director of the New York and Queens Electric Light and Power Company, director and treasurer of the Electrical Testing Laboratories, and a trustee of the Polytechnic Institute of Brooklyn and the Brooklyn Institute of Arts and Sciences. Doctor Parker's activities in the AIEE have been many and diversified. He served as vice-president during 1921–22, and has been a member of the following committees: Student Branches, 1919–20; education, 1919–22 (chairman, 1919–20); Sections, 1920–22; meetings and papers (now technical program), 1919–20; standards, 1923–25 and 1926–32; power generation, 1924–26; power transmission and distribution, 1924–26; electrical machinery, 1924–27; the engineering profession, 1929–31; legislation affecting the engineering profession, 1931–34; and Lamme Medal, 1931–34. Doctor Parker served also as the Institute's representative on the American Standards Association from 1926 until 1932. He is at present a director of the American Standards Association, executive committee member of the Association of Edison Illuminating Companies, and a member of the American Society of Civil Engineers, The American Society of Mechanical Engineers, American Gas Association, Edison Electric Institute, National Industrial Conference Board, Inc., Society for the Promotion of Engineering Education, Sigma Xi, and Tau Beta Pi.

J. C. PARKER

Vice-Presidential Nominees Are Bolton, Dawes, Farmer, Gamble, and Lovell.

Frank Cleveland Bolton (A'09, M'14) vice-president of the Agricultural and Mechanical College of Texas, College Station, has been nominated to serve the Institute as vice-president representing the South West District (number 7). Professor Bolton was born at Pontotoc, Miss., March 24, 1883, and was graduated from Mississippi State College with the degree of bachelor of science in 1905. He pursued graduate studies at Cornell University, University of Chicago, University of Wisconsin, and The Ohio State University. He was awarded the degree of master of science at Ohio State in 1928, and the honorary degree of doctor of laws was conferred on him by

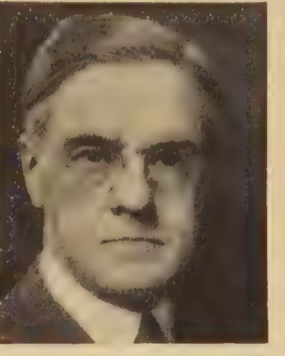
F. C. BOLTON

Austin College in 1932. He was a member of the electrical-engineering faculty of Mississippi State College from 1905 until 1909, during which time he was promoted to an associate professorship. In 1909 Professor Bolton was appointed head of the department of electrical engineering at the Agricultural and Mechanical College of Texas. During the World War he was director of military education activities of the college and was in charge of the training of enlisted men for the technical branches of the army. He has maintained his interest in national defense and until recently held a commission as major in the Signal Corps Reserve. In 1922 Professor Bolton became dean of the school of engineering, and in 1932 was appointed dean of the college, at which time he relinquished his duties as head of the department of electrical engineering, but continued as professor in the department. In 1937 he gave up the position of dean of engineering to become vice-president of the college. Besides his regular duties he has served frequently as a consulting engineer. During 1936 he prepared a report on the cost of electric energy in certain sections of Texas, which was used as a basis for negotiations for marketing publicly produced hydroelectric power. He has been active in promoting a wider use of electricity in rural Texas, is a member of the Texas committee on the relation of electricity to agriculture since its organization in 1927, and since 1935 has been chairman of that organization. Professor Bolton has been active in Institute affairs in Texas and has served on several Section committees. He is a member of the Institute's committee on education and represents the Institute as a member of the Engineers' Council for Professional Development delegatory committee for inspecting the engineering colleges of the fifth region. During 1936–37 he was chairman of the engineering section of the Association of Land Grant Colleges and Universities. Professor Bolton has been active in the Society for the Promotion of Engineering Education, having served as a member of the council, on many committees, as president of the Texas section of the society, and at present as vice-president of the society.

C. L. DAWES

Chester Laurens Dawes (A'12, M'15, F'35) associate professor of electrical engineering at Harvard University, Cambridge, Mass., has been nominated to serve the Institute as vice-president representing the North Eastern District (number 1). Professor Dawes was born November 13, 1886, at Somerville, Mass., and was graduated from Massachusetts Institute of Technology with the degree of bachelor of science in 1909. Following his graduation he was appointed to the faculty of Massachusetts Institute of Technology as an assistant in physics. In the following year he became an assistant in electrical engineering, but after one year went to Harvard University as an instructor in the graduate school of applied science. During 1913–14 Professor Dawes was granted a leave of absence to assume a post at the United States Naval Academy as professor of electrical engineering. From 1916 until 1919 he served as an instructor in electrical engineering at both Harvard University and Massachusetts Institute of Technology, and concurrently (1917–18) was an instructor in electrical engineering and radio at the United States Naval Aviation School at MIT. From 1919 until 1931 he was assistant professor of electrical engineering at the Harvard engineering school, and since 1931 has been associate professor. In addition to his regular teaching duties, Professor Dawes has served as consulting engineer for many commercial organizations, and holds several patents on electrical devices. He is the author of several text books and many papers and articles on a wide variety of electrical subjects. Professor Dawes is at present a member of the Institute's committee on membership and is chairman of the AIEE Boston Section. He has been active in other organizations, having been a member of several committees of the Society of Automotive Engineers, the American Society of Mechanical Engineers, and the National Research Council. He is a Fellow of the American Association for the Advancement of Science and a member of the Society for Promotion of Engineering Education.

Frank Malcolm Farmer (A'02, M'12, F'13, director) vice-president and chief engineer of the Electrical Testing Laboratories, Inc., New York, N. Y., has been nominated to serve the Institute as vice-president representing the New York City District (number 3). Mr. Farmer was born March 28, 1877, at Ilion, N. Y., and was graduated from Cornell University with the degree of mechanical engineer in 1899. In 1903, after spending a year in the test department of the General Electric Company and 2½ years in the inspection division of the United States Navy at the Brooklyn (N. Y.) Navy Yard, he joined the staff of the Electrical Testing Laboratories, Inc., then known as the Lamp Testing Bureau. Mr. Farmer has been active in various phases of the work of the American Standards Association, as chairman of two sectional committees and member of two others, and as a member of the electrical standards committee and the United States National Committee of the International Electrotechnical Commission. Currently the Institute's representative on the United Engineering Trustees, Inc., Mr. Farmer has served on the following committees: standards, 1919–22, 1923 to date; power transmission and distribution, 1920 to the present; electric welding, 1927–28, 1930–31; research, 1929 to the present (chairman 1933–36); technical program, 1933–36; award of Institute prizes, 1933–36; executive, 1934–36, 1937 to the present; Edison Medal since 1934. In addition, Mr. Farmer has been a member of the Institute's board of examiners since 1936, having served previously from 1923 until 1928. He is chairman of the headquarters committee and a member of the committee on Institute policy. Since 1935 he has been Institute representative on the Engineering Foundation board and on the engineering societies monograph committee. Mr. Farmer is a past president of the American Welding Society and of the American Society for Testing Materials, a Fellow of the American Association for the Advancement of Science, and a member of the Institution of Electrical Engineers (Great Britain) and the American Society of Mechanical Engineers.



F. M. FARMER

Lester Raymond Gamble (A'23, M'28) engineer in charge of the electrical department of the Washington Water Power Company, Spokane, has been nominated to serve the Institute as vice-president representing the North West District (number 9). Mr. Gamble was born November 24, 1888, at Carter, Wyo., and received the degree of bachelor of science in electrical engineering at Purdue University in 1914. Following his graduation he entered the employ of the Utah Power and Light Company, Ogden, as a lineman. In 1915 he

L. R. GAMBLE

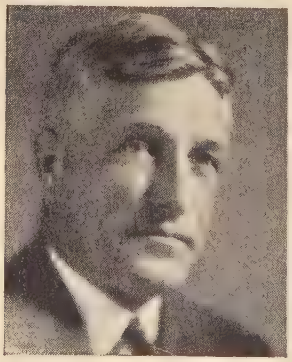
became a draftsman for that company, in which capacity he worked on the design of power plants, transmission lines, and substations. Mr. Gamble was appointed assistant distribution engineer in 1916, but after one year in that position he joined the United States Army as a captain in the Corps of Engineers and was placed in responsible charge of transmission and distribution lines in France. At the end of the World War he returned, in 1919, to his former position with the Utah Power and Light Company, where he remained until 1923. In that year he went to Spokane to take charge of the distribution department of the Washington Water Power Company, where he has since remained. In 1925 he became assistant electrical engineer in charge of transmission and distribution, and in that position his work has involved direction of the transmission and distribution line layout and substation design. During 1925–26 he directed an electric range survey for the heating and cooking committee of the National Electric Light Association, and made a final report of the findings. Since 1930 Mr. Gamble has been engineer in charge of the electrical department, and is responsible for the electrical design of power stations, substations, and transmission and distribution lines of the company; since 1933 he has fulfilled additional duties, including the directorship of the company's construction budget. Mr. Gamble was chairman of the AIEE Spokane Section during 1927–28, and has been a member of the Institute's committee on standards since 1935.

Alfred Henry Lovell (A'12, M'13) assistant dean and secretary of the University of Michigan, Ann Arbor, has been nominated to serve the Institute as vice-president representing the Great Lakes District (number 5). Professor Lovell was born at Hamilton, Ont., Canada, July 13, 1884, and obtained his early education in the public schools of that city and in the Collegiate Institute at Niagara Falls. He received the degree of bachelor of science in electrical engineering at the University of Michigan in 1909 and the degree of master of science from the same institution in 1914. From 1900 until 1911 he had varied experience in design and construction of power generation projects, serving on the engineering staffs of the Ontario Power Company (1902–05), the Telluride Power Company (1906), the Rochester Railway and Light Company (1909–10), and the Gladwin Light and Power Company (1912). During the same period he worked on an appraisal for the Detroit Edison Company, with the Mexia Power and Light Company, and others, and on the rehabilitation design of the Kansas City Railways plant. During 1910–11 he was associated with Muralt and Company, transmission line contractors for the Hydro-Electric Power Commission of Ontario. During the World War Professor Lovell served in the United States, England, and France as Colonel in the United States Army Corps of Engineers, and later commanded the Third Engineers training regiment at Camp Humphreys, Va. After serving for eight years as an instructor, he was appointed professor of electric power engineering at the University of Michigan in 1919, and in 1929 was appointed assistant dean of the college of engineering, later becoming also secretary of the university. Professor Lovell has presented several papers on education and power switching before the Institute, and is the author of a textbook on generating stations. Professor Lovell has been active in the affairs of the Detroit-Ann Arbor Section, having served as secretary-treasurer, vice-chairman, and chairman (1928–29). He has been a member of the Institute's committees on education and power generation. He was a member of the National Electric Light Association's committees on overhead and underground systems, and has been chairman of the committee on electrical engineering of the Society for the Promotion of Engineering Education. Professor Lovell was a director of the Institute from 1932 until 1936.

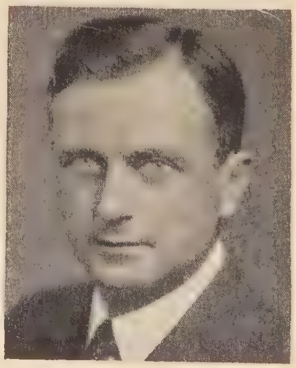
Mapes, Osborne, Prince Nominated for Institute Directorships

Leland Russell Mapes (M'29, F'37) chief engineer of the Illinois Bell Telephone Company, Chicago, has been nominated to serve the AIEE as a member of its board of directors. Mr. Mapes was born March 26, 1892, at Middletown, N. Y., and received his formal technical education at Columbia University, where he was graduated with the degree of electrical engineer in 1913. Immediately following his graduation he became affiliated with the engineering department of the American Telephone and Telegraph Company, New York, N. Y., where he remained until he was transferred to the Illinois Bell Telephone Company in 1925. At that time he was made equipment and building engineer in responsible charge of design and construction of telephone buildings and switchboards throughout the state of Illinois and part of Indiana. Since 1928 Mr. Mapes has been chief engineer in the Chicago area of the Illinois Bell Telephone Company, where he has been in responsible charge of design of all telephone plants in the city of Chicago. He has been active in the Western Society of Engineers, having been successively chairman of the electrical section, a trustee, and a vice-president of that organization. During 1934–36 Mr. Mapes served the Institute as a member of the committee on transfers, and during 1932–33 was chairman of the AIEE Chicago Section.

L. R. MAPES



A. H. LOVELL



H. S. OSBORNE

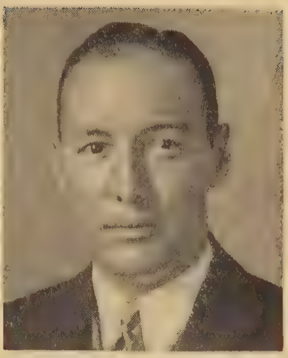
Harold Smith Osborne (A'10, M'15, F'21) transmission engineer, American Telephone and Telegraph Company, New York, N. Y., has been nominated to serve the AIEE as a member of its board of directors. Doctor Osborne was born at Fayetteville, N. Y., August 1, 1887, and studied electrical engineering at Massachusetts Institute of Technology, receiving the degree of bachelor of science (1908) and doctor of engineering (1910). Following his graduation in 1910 he was employed in the office of the transmission and protection engineer of the American Telephone and Telegraph Company, and in 1914 was made assistant to the transmission and protection engineer. Since 1920 he has held his present position as transmission engineer. Doctor Osborne has presented several papers before the Institute and is the author of many technical articles published in standard electrical engineering handbooks and technical periodicals. Several times he has represented the American Telephone and Telegraph Company at meetings of the International Advisory Committee on Telephony in various parts of Europe. In 1934 he represented the United States National Committee at a meeting of the Advisory Committee on Radio of the International Electrotechnical Commission at The Hague, Netherlands. For several years Doctor Osborne has been actively interested in city planning. He is a member of the American Association of Planning Officials, and is active in the work of several local municipal planning boards. At present he is chairman of the Institute's technical program committee and the committee on the award of Institute prizes, and is a member of the committees on publication and co-ordination of Institute activities. He is also an alternate representing the Institute on the American Standards Association and representative on the electrical standards committee of the American Standards Association. Previously Doctor Osborne served on the following committees: standards, 1917–28 (chairman 1923–26); technical program, 1924–25, 1927–29, 1931–34; education, 1928–31; communication, 1929–37 (chairman 1931–34). Doctor Osborne is a member of the Edison Medal committee and represents the Institute on the Alfred Noble prize committee of the American Society of Civil Engineers. He is vice-president of the United States National Committee of the International Electrotechnical Commission; a fellow of

the American Association for the Advancement of Science, American Physical Society, and Acoustical Society of America; and a member of the Institute of Radio Engineers and the Society for the Promotion of Engineering Education.

David Chandler Prince (A'16, F'26) chief engineer of the Philadelphia (Pa.) works of the General Electric Company, has been nominated to serve the AIEE as a member of its board of directors. Mr. Prince was born February 5, 1891, at Springfield, Ill., and received the degrees of bachelor of science in electrical engineering (1912) and master of science in electrical engineering (1913) at the University of Illinois. Following his graduation in 1913 he became affiliated with the General Electric Company at Schenectady, N. Y., as an assistant to Dr. E. F. W. Alexanderson (A'04, F'20) and in that capacity assisted in the design of split-phase locomotives, double-squirrel-cage motors, and other special devices. After one year with the General Electric Company, Mr. Prince was appointed assistant to the electrical engineer of the State Public Utilities Commission of Illinois, where for the next three years his work was concerned with public utility valuations and rate making in the state of Illinois. From 1917 until 1919 Mr. Prince served in the Ordnance Department of the United States Army as first lieutenant in charge of design, production, and application of machine gun equipment for airplanes purchased from the French and British governments. In that capacity he was attached to Air Service Headquarters in Paris, France. At the end of the World War, Mr. Prince returned to the General Electric Company as assistant to Doctor Alexanderson, and during 1919–20 served as engineering representative in Poland during negotiations for a high-power radio station. In 1920 he was appointed a research engineer in the radio department of the General Electric Company, where he became engaged in the evolution of the theory of design of high frequency vacuum tube oscillators and the design of high-voltage thermionic rectifiers and inverters. In 1923 he was placed in charge of research on mercury-arc rectifiers, thyratrons, and associated circuits and apparatus. Mr. Prince has been chief engineer of the Philadelphia works of the General Electric Company since 1931. He is the author of several books on mercury-arc rectifiers and on vacuum tubes and their use as oscillation generators as well as numerous papers and articles on electronic and switchgear apparatus. He is a member of the protective devices committee of the Institute and has been active in the affairs of the AIEE Philadelphia section.

D. C. PRINCE

R. E. DOHERTY



K. S. WYATT

W. I. Slichter
Renominated as Institute Treasurer

Walter Irvine Slichter (A'00, M'03, F'12, national treasurer and past-vice-president) professor of electrical engineering at Columbia University, New York, N. Y., has been renominated to serve as treasurer of the Institute. He has devoted his energies generously to the Institute throughout a long period; since 1914 he has been an active member of 18 different Institute committees and has represented the Institute on six joint bodies. At present he is a member of seven committees and a representative on four bodies. Professor Slichter has been national treasurer since 1930. A full biographical sketch of Professor Slichter was published in Electrical Engineering for March 1937, page 395.

R. E. Doherty
to Receive Lamme Medal

Robert Ernest Doherty (A'16, M'27) president of the Carnegie Institute of Technology, Pittsburgh, Pa., has been awarded the Lamme Medal of the AIEE for 1937 "for his extension of the theory of alternating-current machinery, his skill in introducing that theory into practice, and his encouragement of young men to aspire to excellence in this field." Doctor Doherty was born at Clay City, Ill., January 22, 1885, and received the degree of bachelor of science at the University of Illinois in 1909 and the degree of master of science at Union College in 1921. In 1931 he received the honorary degree of master of arts from Yale University, and more recently the honorary degree of doctor of laws was conferred upon him by Tufts College and the University of Pittsburgh. After his graduation in 1909 he was employed as a student engineer for the General Electric Company, Schenectady, N. Y., and upon completing his period of training he was appointed designing engineer on a-c machinery. In 1920 he became assistant to Doctor C. P. Steinmetz (A'90, M'91, F'12, past-president) and continued to serve in that capacity until the death of Doctor Steinmetz in 1923. In 1922 Doctor Doherty was appointed consulting engineer for the General Electric Company, and after two years in that capacity was selected to organize the advanced course in engineering offered by that company. He was also given the responsibility for educational work among the college graduates employed and trained by the firm. In 1931 Yale University appointed him to its faculty as professor of electrical engineering, and two years later he was made dean of the school of engineering. Doctor Doherty served as a member of the Institute's committee on education during 1918–19 and 1926–28, and as chairman from 1931 until 1935. He was also a member of the committees on electrophysics (now basic sciences), 1924–26; power transmission and distribution, 1928–29; and technical program, 1931–33. During 1926–27 he served as chairman of the AIEE Schenectady Section. Doctor Doherty has contributed much to technical literature, and is the author of numerous papers presented before the Institute. He is a member of the Society for the Promotion of Engineering Education, Tau Beta Pi, Sigma Xi, and Eta Kappa Nu.

K. S. Wyatt (A'32) after nine years as a research engineer on high voltage insulation for The Detroit Edison Company, Detroit, Mich., resigned as of January 1, 1938 to become technical director of the Enfield Cable Works, Ltd., Brimsdowne, Surrey, England. Mr. Wyatt was born at Cambridge, Mass, September 24, 1900, and attended the engineering school of Mt. Allison University, (New Brunswick), but after two years changed to the arts curriculum, receiving the degrees of bachelor of arts in 1921 and bachelor of science in 1922. He then entered the graduate school of Harvard University to pursue studies in physical chemistry. A year later he received a fellowship from the National Research Council of Canada and studied research problems in the supersaturation of gases in liquids at the University of Toronto. In 1922 he became assistant research chemist for the Carborundum Company, Niagara Falls, N. Y., where he conducted researches on porosity determinations of abrasive wheels. As engineer in charge of research of high-voltage cable insulation for The Detroit Edison Company, Mr. Wyatt has been engaged since 1928 in studies of the fundamental materials entering into the manufacture of high-voltage underground cable with the intention of improving cable operation by revealing and making clear the causes of deterioration. One of the researches in which Mr. Wyatt was an active participant is described in a paper in this issue, pages 141–54, on "Mechanical Uniformity of Paper-Insulated Cables," of which he is a co-author. Mr. Wyatt is chairman of the committee on insulating oils of the Utilities Co-ordinated Research and of the subcommittee on chemistry of the electrical insulation committee of the National Research Council, and is active in committee work of the Association of Edison Illuminating Companies. He has been a member of the Institute's committee

on research since 1934, and of the Edison Medal committee since 1933. He is an active member of the American Chemical Society.

G. H. Stickney (A'04, F'24), consulting engineer in the incandescent lamp department of the General Electric Company, Cleveland, Ohio, recently retired after more than 41 years of service in the electrical industry. Mr. Stickney was born October 4, 1872, at Buffalo, N. Y., and studied electrical engineering at Cornell University, where he received the degree of mechanical engineer in electrical engineering in 1896. Following his graduation he entered the student course of the General Electric Company, Schenectady, N. Y., and in 1898 was transferred to the Lynn (Mass.) works of that company. Mr. Stickney's entire professional career has been closely identified with illumination and kindred subjects. In 1909 he was transferred from Lynn to the Schenectady works of the General Electric Company, and for the last eight years he has been at the Nela Park lamp department of the company. Mr. Stickney is president of the United States National Committee of the International Commission on Illumination, and in 1934 he headed a United States delegation attending a meeting of the Commission in Germany. On the same trip he represented the United States on the standardization of lamp bases and sockets at the International Electrotechnical Commission meeting at Brussels, Belgium. During the World War Mr. Stickney was president of the Illuminating Engineering Society when that group rendered effective service to the government. He has served the Institute as a member of the committees on production and application of light, 1914–16, 1919–33 (chairman 1921–25); meetings and papers (now technical program), 1921–25; and standards, from 1923 to date. Mr. Stickney is a fellow of the American Association for the Advancement of Science and a member of Sigma Xi.

D. W. McLenegan (A'24, M'31) assistant commercial engineer in the air conditioning department of the General Electric Company, Bloomfield, N. J., has been appointed manager of the General Electric Air Conditioning Institute. A native (1900) of Milwaukee, Wis., Mr. McLenegan is a mechanical engineering graduate of the University of Wisconsin. Following his graduation he spent two years at the University as assistant and instructor in engineering mathematics before becoming affiliated with the research laboratories of the General Electric Company in 1922. The following year he was transferred to the industrial engineering department and later was sent to Bloomfield to work in the air conditioning department of the company. Mr. McLenegan is a member of the American Society of Refrigerating Engineers.

J. R. Hango (A'31) who has been assistant electrical engineer for the Saguenay Power Company, Ltd., Arvida, Que., Canada, recently became the power engineer for that company. Born in 1904 at Brockett, N. D., Mr. Hango was graduated from the University of Alberta in 1929 with the degree of bachelor of science in electrical engineering. Following a brief test course with the Canadian Westinghouse Company at Hamilton, Ont., he joined the Duke-Price Power Company, Ltd., which later became the Saguenay Power Company, Ltd., as assistant to the electrical engineer. In 1930 he became assistant to the superintendent of operation, and in 1931 was appointed assistant electrical engineer.

Alex Dow (A'93, F'13, HM'37, Edison Medalist '36, member for life) president of The Detroit Edison Company, Detroit, Mich., recently was elected an honorary life member of the Institution of Mechanical Engineers (Great Britain). A biographical sketch of Doctor Dow appeared on page 1919 of the July 1937 issue of Electrical Engineering, at the time of his election to honorary membership in the AIEE.

Darrow Sage (A'01) superintendent of the Kearny (N. J.) generating station of the Public Service Electric and Gas Company for the last ten years, recently was made mechanical maintenance engineer in the general office of the electric generating department at Newark. Mr. Sage has been associated with the Public Service Company since 1920.

H. A. Kidder (A'06, F'29) superintendent of motive power, Interborough Rapid Transit Company, New York, N. Y., has been elected treasurer of the Engineers' Club (New York) for the current year and a trustee to hold office until 1942.

W. R. Whitney (A'01, Edison Medalist '34, member for life) vice-president in charge of research of the General Electric Company, Schenectady, N. Y., recently was elected a life member of the corporation of the Massachusetts Institute of Technology.

Obituary

Charles Waterman Stone (A'03, M'06, F'12' past vice-president) consulting engineer for the General Electric Company, Schenectady, N. Y., died February 3, 1938. Mr. Stone was born December 24, 1874 at Providence, R. I., and attended the University of Kansas. In 1894 he joined the Franklin Electric Company, Kansas City, Mo., but in 1896 went to Bedford, Mass., as a machinist for the W. S. Hill Electric Company where he soon was advanced to the position of engineer in charge. In 1899 Mr. Stone was appointed superintendent of construction for the Hancock Equipment Company, Boston, Mass., of which he remained a member until he joined the General Electric Company in 1900. In 1901 he was assigned to switchgear engineering work, and in 1904 was transferred to the lighting engineering department. Mr. Stone was appointed manager of the lighting department in 1912, and continued in that position until 1928, when he became a consulting engineer of the General Electric Company. Mr. Stone was active in the affairs of the Radio Corporation of America from the time of its organization, and in 1927 became assistant to the president of that corporation. Mr. Stone was a member of the Institute's committee on lighting and illumination (now production and application of light) from 1914 until 1916. He was a manager of the Institute from 1908 until 1911 and a vice-president from 1911 until 1913.

Howard Tuxbury Sands (A'10, M'27) retired vice-president of the Electric Bond and Share Company, New York, N. Y., died January 13, 1938. Mr. Sands was born September 12, 1867, at Saco, Me. In 1896 he became superintendent of the Mechanic Falls (Me.) Water, Electric Light, and Power Company, where he remained for five years before becoming superintendent of the Lewiston and Auburn Electric Light Company, Lewiston, Me. From 1905 until 1909 he was manager of the Haverhill Electric Company, Haverhill, Mass., and in the latter year he became general manager for Charles H. Tenney and Company, Boston, Mass., later (1915) becoming vice-president of that company. In 1926 Mr. Sands became vice-president of the Electric Bond and Share Company and held that position for ten years before retiring to become director of the company's holdings in Brazil.

Bennett Mattingly Brigman (M'28) dean of the Speed Scientific School, University of Louisville (Ky.), died February 8, 1938. Dean Brigman, born February 25, 1881, at Louisville, attended the University of Kentucky, received the degree of bachelor of science (1908) and master of science (1912) at the University of Louisville, and studied in the graduate school of the University of Wisconsin. After teaching in Louisville high schools for several years, he joined the teaching staff of the University of Louisville in 1912. In 1923 he organized the Speed Scientific School of that institution and was made its dean, a position he held continuously. Dean Brigman was active in the American Society of Mechanical Engineers, having held many offices and committee memberships in that organization, and recently was elected a vice-president of the Society for the current year.

Eugene Russell Carichoff (A'94, M'00) electrical engineer in the industrial control department of the General Electric Company, Schenectady, N. Y., died January 31, 1938. Mr. Carichoff was born in Virginia in November 1860, and was graduated from Washington and Lee University with the degree of master of arts in 1885. Following his graduation he served one year as an instructor in French and German at the State Normal College at Florence, Ala., and in 1886 became professor of Latin and physics at Central University. In 1888 he became a tester for the Edison Phonograph Company, and later was placed in charge

of testing electric welding machines for the Thomson Electric Welding Company at Lynn, Mass. After a brief affiliation as electrical engineer with the Yale and Towne Manufacturing Company, Mr. Carichoff entered the graduate school of The Johns Hopkins University as an applicant for the degree of doctor of philosophy in physics. In 1894, however, he decided not to finish his graduate studies, and he became associated with the Sprague Electric Company and soon was placed in responsible charge of the design, construction, and testing of much of the control apparatus manufactured by that company. For a time Mr. Carichoff maintained his own consulting engineering offices at New York, N. Y., but in 1908 he joined the railway engineering department of the General Electric Company, later being transferred to the industrial control department, where he remained for many years.

William Macy Joy (A'06, M'19) assistant electrical engineer, Phoenix Engineering Corporation, New York, N. Y., died February 5, 1938. Mr. Joy was born July 21, 1877, at Mount Vernon, N. Y., and was graduated from Tufts College with the degree of bachelor of science in electrical engineering in 1901. Immediately following his graduation, he became affiliated with the Trinidad Electric Company, Ltd., Port of Spain, Trinidad, where he remained for six years and eventually became chief engineer of the power and lighting system of that company. In 1907 he became electrical engineer for the Porto Rico Railway Light, and Power Company, San Juan. In 1911 Mr. Joy joined the engineering staff of the Electric Bond and Share Company and associated companies, with offices at New York, N. Y., where he was actively engaged for more than 26 years.

George Roy Wright (A'12) district manager of the Canadian General Electric Company, Ltd., Vancouver, B. C., died January 1, 1938. Mr. Wright was born September 28, 1882, at Salisbury, N. B., and received the degree of bachelor of arts at Mt. Allison University in 1903. He then continued his engineering studies at McGill University, receiving the degree of bachelor of science in 1907. Immediately following his graduation in 1906, Mr. Wright joined the electrical engineering staff of the Canadian General Electric Company in Peterboro, Ont., and later was transferred to Toronto. He then went to Vancouver, and in 1916 became manager of the company's Manitoba division, with headquarters in Winnipeg. He remained in that position until 1925, when he returned to Vancouver.

Charles Max (A'26, M'30) engineer salesman for Siemens Schuchert, Oslo, Norway, died some time ago according to word just received at Institute headquarters. Mr. Max was born September 27, 1891, and attended the Technical School Porsgrund and New York University. Mr. Max pursued many phases of engineering work in Norway, the United States, and West Africa.

Membership

Recommended for Transfer

The board of examiners, at its meeting on February 17, 1938, recommended the following members for transfer to the grade of membership indicated. Any objection to these transfers should be filed at once with the national secretary.

To Grade of Fellow

Ball, Thomas F., head, department of electrical engineering, University of South Carolina, Columbia.
Bartlett, Lawrence, chief electrical engineer, Cities Service Company, New York, N. Y.
Carter, L. L., assistant chief engineer, Anaconda Wire and Cable Company, Hastings-on-Hudson, N. Y.
Hogg, T. H., chairman and chief engineer, Hydro-Electric Power Commission of Ontario, Toronto.

4 to Grade of Fellow

To Grade of Member

Abbott, H. H., member of technical staff, Bell Telephone Laboratories, Inc., New York, N. Y.
Chamberlain, R. F., professor of electrical engineering, Cornell University, Ithaca, N. Y.
Ellenberger, Wm. J., power engineer, Potomac Electric Power Company, Washington, D. C.
Hegazy, H. M., head of electrical section, physical department, Public Works Ministry, Cairo, Egypt.
Keith, F. E., electrical installation division, General Electric Company, Chicago, Ill.
Lilja, E. D., electrical engineer, Barber-Colman Company, Rockford, Ill.
Lowe, H. L., electrical distribution and transmission department, Louisville Gas and Electric Company, Louisville, Ky.
Nash, D. O., engineer, General Cable Corporation, New York, N. Y.
Segel, H., cable engineer, Anaconda Wire and Cable Company, Hastings-on-Hudson, N. Y.
Siddons, E. C., junior engineer, Consolidated Edison Company of New York, Inc., New York, N. Y.

10 to Grade of Member

Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. If the applicant has applied for direct admission to a grade higher than Associate, the grade follows immediately after the name. Any member objecting to the election of any of these candidates should so inform the national secretary before March 31, 1938, or May 31, 1938, if the applicant resides outside of the United States or Canada.

United States and Canada

Abright, R., Jr., A-Bright Electric Company, Dallas, Texas.
Acton, E. S., General Electric Company, Schenectady, N. Y.
Aitken, D. R., Aluminum Company of America, Alcoa, Tenn.
Allen, H. B., N.Y.C. & St. L. Railroad, Cleveland, Ohio.
Allen, O. L., Northwestern Public Service, Armour, S. D.
Allen, O. T., Tennessee Valley Authority, Chattanooga, Tenn.
Allen, R. L., Box 923, Bessemer, Mich.
Antippa, F. G., 2705 Hearst Avenue, Berkley, Calif.
Arnaud, F. J., Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
Arnold, B. A., Southwestern Light and Power Company, Lawton, Okla.
Ast, P. F., 446 East 85th Street, New York, N. Y.
Bacabac, F. C., Post Office Box 250, Carmel, Calif.
Baker, P. K., Ohio Bell Telephone Company, Cleveland, Ohio.
Baker, R. L., District of Columbia Highway Department, Washington, D. C.
Ballentine, W. E., Chesapeake and Potomac Telephone Company of West Virginia, Morgantown.
Barrett, W. G., American Telephone and Telegraph Company, New Orleans, La.
Barnes, F. P., General Electric Company, Schenectady, N. Y.
Bass, N. I., Houston Lighting and Power Company, Rosenberg, Texas.
Basci, J., Staten Island Edison Corporation, New York, N. Y.
Bassett, H. L., General Electric Company, Pittsfield, Mass.
Batchelor, J. W., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Bauer, L. J., Washington Water Power Company, Spokane, Wash.
Baum, R. S., Bethlehem Steel Company, Johnstown, Pa.
Becker, H. W., Fireman's Fund Indemnity Company, New York, N. Y.
Bedford, P. L., Commonwealth Edison Company, Chicago, Ill.
Beede, H. M., 41 Cowdrey Avenue, Lynn, Mass.
Beeswy, R. J., Inland Steel Company, East Chicago, Ind.
Beichley, F. W., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Beitler, P. L., Route 4, Box 75 A, Waukesha, Wis.
Bennon, S., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Berger, R., Condi-Lite Corporation, New York, N. Y.
Bergman, S. D., Adding Machine Service Company, New York, N. Y.
Berndes, E., Jr., Texas Development Corporation, Houston, Texas.
Berry, R. N., F. S. Payne Company, Cambridge, Mass.
Bickel, W. R., Union Electric Company of Missouri, Webster Groves.
Birckhead, L. (Member), Consolidated Gas Electric Light and Power Company of Baltimore, Baltimore, Md.
Birdsall, L. C., Automatic Electric Company, Chicago, Ill.
Biven, D. F., 2301 South Eighth Street, Kansas City, Kans.
Bixler, O. C., Southern California Edison Company, Ltd., Los Angeles, Calif.
Blake, H. F., Western Electric Company, Kearny, N. J.
Blacksmith, S. M., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Bleiweiss, A. F., 1162 Garrison Avenue, New York N. Y.
Bloom, C. R., Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
Boening, E. R., Wisconsin Public Service Corporation, Oshkosh, Wis.
Bogdanowicz, W. A., Crocker Wheeler Electric Manufacturing Company, Ampere, N. J.
Bouton, M. N., Wagner Electric Corporation, St. Louis, Mo.
Bradley, J. J., General Electric Company, Philadelphia, Pa.
Brauer, H. H., Shure Brothers, Chicago, Ill.
Braun, I. W., Cutler Hammer, Inc., Milwaukee, Wis.
Breslauer, N. P., Allen Bradley Company, Milwaukee, Wis.
Breunig, W. H., Liebel-Flarsheim Company, Cincinnati, Ohio.
Brown, H. I., Freeport Sulphur Company, Ft. Sulphur, La.
Brown, T. R., General Electric Company, Schenectady, N. Y.
Brown, W. B., General Electric Company, Schenectady, N. Y.
Brubaker, J. F., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Buchanan, L. W., Westinghouse Electric and Manufacturing Company, Lima, Ohio.
Buford, W. R., Humble Oil and Refining Company, Snyder, Texas.
Bullington, R. K., Bell Telephone Laboratories, Inc., New York, N. Y.
Bunnell, R. F., Warner Brothers Pictures, Inc., Burbank, Calif.
Burrell, K. H., General Electric Company, Ft. Wayne, Ind.
Burritt, A. H., Eastman Kodak Company, Rochester, N. Y.
Burroughs, J. E., General Electric Company, Schenectady, N. Y.
Butler, O. D., Commonwealth Edison Company, Chicago, Ill.
Byrne, M. E., Idaho Power Company, Boise, Idaho.
Byrum, C. F., General Electric Company, Schenectady, N. Y.
Caldwell, C. H. Jr., Imperial Paper and Color Corporation, Glens Falls, N. Y.
Calhoun, M. L., British Columbia Electric Railway Company, Ltd., Vancouver, B. C., Canada.
Campbell, C. M. Jr., General Electric Company, Pittsfield, Mass.
Campbell, H. W., Bethlehem Steel Company, Naginey, Pa.
Campbell, J. M., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Cardani, C. P., Delco Products Corporation, Dayton, Ohio.
Carew, W. E., Jr., Factory Insurance Association Hartford, Conn.

Carlberg, N. E., 6834 19th Avenue, N. E., Seattle, Wash.
Carpenter, T. J., General Electric Company, Pittsfield, Mass.
Carsten, W. J., Bureau of Power and Light, Los Angeles, Calif.
Casey, E. J., General Electric Company, Erie, Pa.
Caton, D. L., Bell Telephone Company of Pennsylvania, New Castle.
Cavner, C. M., Southern California Edison Company, Ltd., Los Angeles, Calif.
Chamberlain, I. J., General Electric Company, Schenectady, N. Y.
Chappell, J. F., 107 West Water Street, Montpelier, Ohio.
Chase, G. E., Dayton Power and Light Company, Dayton, Ohio.
Cheadle, J. N., Salem, S. D.
Churchill, A. A., General Electric Company, Pittsfield, Mass.
Clay, R. G., 306 East Second Street, Metropolis, Ill.
Claypoole, L. E., Armco, Butler, Pa.
Cofer, J. W., Kentucky and West Virginia Power Company, Pikeville, Ky.
Coles, D. J., Jr., W. J. McCahan Sugar Refinery and Molasses Company, Philadelphia, Pa.
Constantine, C. B., The Pennsylvania Railroad, Philadelphia, Pa.
Cook, J. H., Massachusetts Institute of Technology, Cambridge.
Corden, H. F., Tennessee Valley Authority, Chattanooga, Tenn.
Cornforth, C. W., Public Service Electric and Gas Co., Newark, N. J.
Craddock, J. M., Humble Oil and Refining Company, Houston, Texas.
Crawford, S. T., Jr., Chrysler Institute of Engineering, Highland Park, Mich.
Crawford, W. R., Ohio Power Company, Newark, Ohio.
Crumb, A., General Electric Company, Schenectady, N. Y.
Curry, R. S. Jr., General Electric Company, Schenectady, N. Y.
Cwiklo, E. C., General Electric Company, Schenectady, N. Y.
Daubaras, E. J., 134 Himrod Street, Brooklyn, N. Y.
Daugherty, R. H., Jr., Southern Bell Telephone and Telegraph Company, Harlan, Ky.
Davis, H. B. O., Ray W. Chanaberry, Inc., Louisville, Ky.
Denton, R. H., Eclipse Aviation Corporation, East Orange, N. J.
De Feo, R. V., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
De Smidt, W. A., Allen Bradley Company, Milwaukee, Wis.
Dicker, H. B., Republic Steel Corporation, Cleveland, Ohio.
Dickler, G. B., The Arundel Corporation, Baltimore, Md.
Dillon, J. A., Alabama Power Company, Birmingham.
Dillon, P. L., General Electric Company, Schenectady, N. Y.
Dobry, A., 2315 South Flower, Los Angeles, Calif.
Dodson, J. W., Oklahoma Gas and Electric Company, Ada.
Dodt, D. H., Indiana and Michigan Electric Company, Fort Wayne, Ind.
Dolasa, S. R., Associated Cement Company, Bombay, Ind.
Donaldson, M. L., Westinghouse Electric and Manufacturing Company, Houston, Texas.
Donelian, K. O., American District Telegraph Company, New York, N. Y.
Dong, P. L., 5222 Vine Street, Philadelphia, Pa.
Doran, M. P., Harry Alexander, Inc., Washington, D. C.
Dow, W. K., Aluminum Company of Canada, Ltd., Quebec, Canada.
Doyle, H. K. (Member), Dallas Power and Light Company, Dallas, Texas.
Drew, H. B., Alabama Power Company, Birmingham.
Dutenhaver, R. E., Duncan Electric Company, Lafayette, Ind.
Duval, R. H., California Institute of Technology, Pasadena.
Dyer, C. E., Aluminum Company of America, Alcoa, Tenn.
Eannarino, S. F., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Easley, G. J., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Edenborough, L. A., Public Service Company of Oklahoma, Okmulgee.
Edson, W. A., Bell Telephone Laboratories, Inc., New York, N. Y.
Edwards, P. C. Jr., 10 Courtland St., Pittsfield, Mass.
Ehrbar, R. D., Bell Telephone Laboratories, Inc., New York, N. Y.
Elliott, F. D. (Member), Imperial Irrigation District, Imperial, Calif.
Engineer, J. D., General Electric Company, Pittsfield, Mass.
Erickson, A. R., General Electric Company, Schenectady, N. Y.
Evans, J. N., General Electric Company, Schenectady, N. Y.
Evans, P., Jr., Purdue University, West Lafayette, Indiana.
Fahrner, T., Stone and Webster Engineering Corporation, Barstow, Calif.
Faithorn, N. R., 2602 Sacramento Street, San Francisco, Calif.
Farmer, V. J., Union Electric Company of Missouri, St. Louis.
Farrell, W. H., General Electric Company, Bridgeport, Conn.
Federing, A. M., 1479 Macombs Road, New York, N. Y.
Feingold, W., Roller Smith Company, Bethlehem, Pa.
Feinman, B., General Electric Company, Fort Wayne, Ind.
Fenn, R. T., Community Light and Power Company, Inc., Middlebury, Vt.
Fincher, R. M., Market Street Railway Company, San Francisco, Calif.
Findley, J. D. Jr., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Findling, W. F., Standard Oil Company, Inc., Whiting, Ind.
Fishbeck, C. E., Detroit Edison Company, Detroit, Mich.
Foldes, S., 2630 North Moreland Boulevard, Cleveland, Ohio.
Fontana, W. J., Montague Court Building, Brooklyn, N. Y.
Ford, P. C., Wagner Electric Corporation, St. Louis, Mo.
Francis, G. F., United Geophysical Company, Pasadena, Calif.
Frantz, J. D., Northwestern Electric Company, Portland, Ore.
Freinkel, L., 2604 University Avenue, New York, N. Y.
Fritz, J. R., 346 North Sixth Street, Reading, Pa.
Fuller, W. R. (Member), Consolidated Edison Company of New York, Inc., New York, N. Y.
Galbraith, R. A., The Detroit Edison Company, Detroit, Mich.
Gall, R. G., Electro Dynamic Company, Bayonne, N. J.
Gambrill, R. D., Locke Insulator Corporation, Baltimore, Md.
Ganiere, W. J., Allis-Chalmers Manufacturing Company, West Allis, Wis.
Gannon, P. E., Burlington, Wash.
Garber, A. J., Massachusetts Institute of Technology, Cambridge.
Garten, R. E. Jr., Continental Oil Company, Ponca City, Okla.
Gavrilov, A. A., Pacific Gas and Electric Company, San Francisco, Calif.
Geiser, K. R., General Electric Company, Schenectady, N. Y.
Gerig, F. L., Cutler-Hammer, Inc., Milwaukee, Wis.
Gilbert, S. M., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Gilcrease, E. E., Moloney Electric Company, St. Louis, Mo.
Gissing, H. R., Northern Electric Company, Vancouver, B. C., Canada.
Goetter, W. F., General Electric Company, Erie, Pa.
Godfrey, J. W., Texas Electric Service Company, Wichita Falls.
Goldbaum, L. (Member), Sperry Gyroscope Company, Brooklyn, N. Y.
Goldschmidt, E., Radio Navigational Instrument Corporation, New York, N. Y.
Graham, R. S., Bell Telephone Laboratories, Inc., New York, N. Y.
Gray, F. P., University of Washington, Seattle.
Gray, T. H., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Graybeal, T. D., Massachusetts Institute of Technology, Cambridge.
Graybill, H. W., Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.
Greber, E. G. Jr., Southwestern Bell Telephone Company, Oklahoma City, Okla.
Green, R. C., Dallas Power and Light Company, Dallas, Texas.
Gregory, H. S., University of Florida, Gainesville.
Grillo, J., Ward Leonard Electric Company, Mt. Vernon, N. Y.
Grim, S. H., Consolidated Edison Company of New York, Inc., New York, N. Y.
Groncki, J. J., General Electric Company, Lynn, Mass.
Halberstadt, H. J., International Business Machines Corporation, Endicott, N. Y.
Haas, J., Interborough Rapid Transit Company, New York, N. Y.
Halfmann, E. S., Philadelphia Electric Company, Philadelphia, Pa.
Hand, A. A., Bell Telephone Laboratories, Inc., New York, N. Y.
Hatker, N. W., Bentley Construction Company, Toledo, Ohio.
Harder, R. B., Western Electric Company, Chicago, Ill.
Harris, L. D., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Harris, S. J., Holophane Company, New York, N. Y.
Heer, R. H., The Garden City Company, Garden City, Kansas.
Henderson, J. W., Washington Suburban Sanitary District, Hyattsville, Md.
Henricksen, N. K., 2253 North LaCrosse Avenue, Chicago, Ill.
Herr, F. L., Herco Oil Burner Corporation, Lancaster, Pa.
Hicks, B. O., Metropolitan Water District of Southern Calif., Banning, Calif.
Hilding, H. W., Hobart Brothers Company, Troy, Ohio.
Hitt, H. H., Southwestern Light and Power Company, Lawton, Okla.
Hoelzle, F. C., Bureau of Marine Inspection and Navigation, Washington, D. C.
Holmes, R. H., General Electric Company, Schenectady, N. Y.
Horn, H. W., University of Illinois, Urbana.
Howard, S. B., General Electric Company, Pittsfield, Mass.
Howell, O. F. Jr., Tennessee Electric Power Company, Chattanooga, Tenn.
Hrabak, R. A., Holophane Company, Inc., Newark, Ohio.
Hribar, S. R., General Electric Company, Pittsfield, Mass.
Huette, W. F., Allen Bradley Company, Milwaukee Wis.
Hulburt, H. T., Columbus and Southern Ohio Electric Company, Columbus, Ohio.
Hunter, J. S., General Electric Company, Schenectady, N. Y.
Hurd, O. W., Northwestern Electric Company, Portland, Ore.
Hutchison, P. C., Cutler-Hammer, Inc., Milwaukee, Wis.
Hyman, S. L., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Ilse, F. J., Goodyear Tire and Rubber Company, Akron, Ohio.
Jackson, J. E., Caterpillar Tractor Company, Peoria, Illinois.
Jakielski, E. J., Wilbur B. Driver Company, Newark, N. J.
Jaques, C. A. (Member), Public Service Company of Northern Illinois, Chicago, Ill.
Johnson, F. J. (Member), Consolidated Edison Company of New York, Inc., New York, N. Y.
Johnson, H. S., Portland General Electric Company, Portland, Ore.
Jones, R. W., Automatic Electric Company, Chicago, Ill.
Jump, J. E., Crocker-Wheeler Electric Manufacturing Company, Ampere, N. J.
Karlskind, D. B., Western Electric Company, Kearny, N. J.
Karns, R. W., General Electric Company, Pittsfield, Mass.
Keller, E. L., General Motors Corporation, Anderson, Ind.
Kent, H. A., 2012 West Jackson Boulevard, Chicago, Ill.
Kessel, H. R., 446 Sheffield Avenue, Brooklyn, N. Y.
Kewley, R. K., Lincoln Electric Company, Cleveland, Ohio.
Kineke, J. H., New York Telephone Company, New York, N. Y.
King, J. L., General Eelectric Company, Pittsfield, Mass.
King, L., Tennessee Valley Authority, Pickwick Dam, Tenn.
Klinksiek, W., Elliott Company, Jeannette, Pa.
Knapp, W., Jr., R.F.D. 5, Lancaster, Pa.
Kochendoerffer, W. C. (Member), Consolidated Edison Company of New York, Inc., New York, N. Y.
Koons, H. R., 410 Riverside Drive, Rome, N. Y.
Kozik, M., Central Hudson Gas and Electric Corporation, Poughkeepsie, N. Y.
Kubacki, W., Landis Machine Company, Waynesboro, Pa.
Kundel, T., Plasterco, Va.
Kupka, E.P., Electro-Motive Corporation, McCook, Ill.
Lanctot, E. K., General Electric Company, Schenectady, N. Y.
Langhorne, H. F., University, Va.
Langohr, G. F., New York and Queens Electric Light and Power Company, Flushing, N. Y.
Lakin, O. H., Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
Lane, B. C., Commonwealth Edison Company, Chicago, Ill.
Leach, H. W., John Tarleton Agricultural College, Tarleton Station, Texas.
Ledbetter, E. R., General Electric Company, Fort Wayne, Ind.
Lee, A. R., General Electric Company, Schenectady, N. Y.
Leffel, J. C., Michigan Bell Telephone Company, Benton Harbor.
Leich, D. L., General Electric Company, Philadelphia, Pa.
Leithold, K. K. Wilshire Oil Co., Long Beach, Calif.
Lemire, R., Hydro-Electric Power Commission of Ontario, Toronto, Ont., Canada.
LeRoy, R. E., General Electric Company, Schenectady, N. Y.
Lester, P. S., RCA Manufacturing Company, Harrison, N. J.
Levy, G. F., United Air Lines Transport Corporation, Chicago, Ill.
Lewis, C. E., Safe Harbor Water Power Corporation, Conestoga, Penna.
Lippert, G. D., American Gas and Electric Company, New York, N. Y.
Lischer, L. F., Commonwealth Edison Company, Chicago, Ill.
Loew, H. R., General Electric Company, Schenectady, N. Y.
Long, M., 520 East Seventh Avenue, Vancouver, B. C. Canada.
Longacre, R. E., Haughton Elevator Company, Toledo, Ohio.
Lotz, E. L., The Johns Hopkins University, Baltimore, Md.
Lotze, A. W. Jr., Indiana Bell Telephone Company, Indianapolis, Ind.
Lusas, S. T., Scovill Manufacturing Company, Waterbury, Conn.

Lyall, R. M., General Electric Company, Schenectady, N. Y.
Lyle, G. H., Morton High School and Junior College, Cicero, Ill.
Lynch, J. C., Reliance Electric and Engineering Company, Cleveland, Ohio.
Lyon, J. A., Utility Management Corporation, Reading, Pa.
Malthaner, W. A., Bell Telephone Laboratories, Inc., New York, N. Y.
Manring, R. C., Western Electric Company, Kansas City, Mo.
Marchand, N., Knapp Monarch Company, New York, N. Y.
Marmaros, H. E., Doan Electric Company, Cleveland, Ohio.
Marohn, R. P., Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
Marvin, J. R., Arkansas State College, Jonesboro.
Matheis, C. E., Cutler-Hammer, Inc., Milwaukee, Wis.
Mathews, J. B., Southern Bell Telephone and Telegraph Company, New Orleans, La.
McAllister, D. H., General Electric Company, Schenectady, N. Y.
McCann, W. R., 211 Oakwood Avenue, Hopewell, Va.
McCarn, G. B., Mountain States Telephone and Telegraph Company, Denver, Colo.
McCoy, E. K., Ohio Bell Telephone Company, Columbus.
McGaffin, J. R., U. S. Electrical Motors, Brooklyn, N. Y.
McKee, H. W., Commonwealth Edison Company, Chicago, Ill.
McKinney, E. B., General Electric Company, Schenectady, N. Y.
Mead, G. E., Seattle Light Department, Seattle, Wash.
Meeks, H. W., Power and Water Department, Sheffield, Ala.
Mehaffey, W. R., 1400 Summerdale Avenue, Chicago, Ill.
Meldrim, E. T., Pacific Gas and Electric Company, Oakland, Calif.
Merrell, T. Y., General Electric Company, Pittsfield, Mass.
Mezek, M. E., Commonwealth Edison Company, Chicago, Ill.
Miller, E. A., 1342 South Milwaukee Street, Denver, Colo.
Miller, J. R., Western Electro Mechanical Company, Oakland, Calif.
Mitkewich, W. (Member), New York City Topographical Dept., New York, N. Y.
Moffet, J. A., Atlantic Refining Company, Philadelphia, Pa.
Montgomery, R. W., General Electric Company, Schenectady, N. Y.
Morgan, F. L. (Member), Southwestern Gas and Electric Company, Fayetteville, Ark.
Morley, D. M., General Electric Company, Schenectady, N. Y.
Moss, E. H., Jr., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Muckenhirn, O. W., 463 Commonwealth Avenue, Boston, Mass.
Muehleisen, O. A., West Penn Power Company, Pittsburgh, Pa.
Mull, M. W., Magnolia Petroleum Company, Beaumont, Texas.
Mullins, F. G., Jr., Carnegie Illinois Steel Corporation, Braddock, Pa.
Murphy, C. S., Boston Fire Department, Boston, Mass.
Murray, F. H., Dayton Power and Light Company, Dayton, Ohio.
Myers, E. H., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Nalle, D. H., Kentucky and West Virginia Power Company, Ashland, Ky.
Nestler, W. W., Southern California Telephone Company, Los Angeles, Calif.
Newman, F. W., 28 Pratt Avenue, Beverly, Mass.
Newman, J. C., Coachella Valley Home Telephone and Telegraph Company, Thermal, Calif.
Nichols, C. H., International Business Machines Corporation, Endicott, N. Y.
Noodleman S., Delco Products Corporation, Dayton, Ohio.
O'Brien, R. C., International Nickel Company, Sudbury, Ont., Canada.
O'Conor, D. J., Jr., Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
Odening, C. A., National Carbon Company, Lakewood, Ohio.
Okress, E. C., 18891 Filer Avenue, Detroit, Mich.
Oliphant, J. D., Bureau of Power and Light, Wilmington, Calif.
Ostendorf, E. W., Aluminum Company of America, Alcoa, Tenn.
Osgood, L. T., General Electric Company, Schenectady, N. Y.
Park, W. G., 27 Audubon Place, Tuscaloosa, Ala.
Peck, H. B., Consolidated Gas Electric Light and Power Company, Baltimore, Md.
Pekkola, A. J., 3900 Whitman Avenue, Cleveland, Ohio.
Pentico, G. W. A., Bell Telephone Laboratories, Inc., New York, N. Y.
Perry, W. A. (Member), Inland Steel Company, East Chicago, Ind.
Person, G. H., Jr., General Electric Company, Fort Wayne, Ind.
Peterson, L. G., General Electric Company, Schenectady, N. Y.
Peterson, R. S. (Member), Commonwealth Edison Company, Chicago, Ill.
Petrich, A. C., Garland Affolter Engineering Corporation, Seattle, Wash.
Piccione, N. E., Electricity Department, Florence, Ala.
Pierson, P. R. (Member), Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Piper, W. G., Westinghouse Electric and Manufacturing Company, New York, N. Y.
Pirtle, J. L., 1646 Troy Avenue, Brooklyn, N. Y.
Plotz, R. S., Bell Telephone Laboratories, Inc., New York, N. Y.
Polson, J. A., Canadian General Electric Company, Ltd., Peterboro, Ont., Canada.
Porter, G. J., Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa.
Ports, D. C., Jansky and Bailey, Washington, D. C.
Powell, C. S., Holly Sugar Corporation, Sidney, Mont.
Prichard, T. P., 612 Ansel Avenue, Burlingame, Calif.
Prior, A. H., Ohio Edison Company, Akron.
Proudfoot, C. E., 75 Wallace Street, West Somerville, Mass.
Queisser, R. C., Sameth Exterminating Company, Inc., New York, N. Y.
Rath, W. F., 1208 Jefferson Avenue, Brooklyn, N. Y.
Ray, W. B., Pacific Gas and Electric Company, San Francisco, Calif.
Rector, A. H., General Electric Company, Schenectady, N. Y.
Redemske, R. F., Bell Telephone Laboratories, Inc., New York, N. Y.
Remark, P. D., Ohio Brass Company, Barberton, Ohio.
Rich, E. A., General Electric Company, Schenectady, N. Y.
Riley, R. H., Jr., Black and Decker Manufacturing Company, Towson, Md.
Rixse, J. H., Jr., Potomac Electric Power Company, Washington, D. C.
Robinson, F. P., Jr., General Electric Company, Schenectady, N. Y.
Robnett, V. P. (Member), Brooklyn Edison Company, Brooklyn, N. Y.
Roller, M. P., Chicago, Rock Island and Pacific Railway Company, Chicago, Ill.
Rosen, M. W., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Roughley, T. H., Detroit Edison Company, Detroit, Mich.
Russell, W. C., General Electric Company, Pittsfield, Mass.
Ryan, C. E., Electrical Testing Laboratories, New York, N. Y.
Salati, O. M., RCA Manufacturing Company, Camden, N. J.
Sawdey, R. S., Jr., Ohio Edison Company, Akron.
Schille, C. A., Sargent and Lundy, Chicago, Ill.
Schiller, E. J., Jr., General Electric Company, Schenectady, N. Y.
Schnabel, A. E., Consolidated Edison Company of New York, Inc., New York, N. Y.
Schneider, R. A., Schweitzer and Conrad Company, Chicago, Ill.
Schrameck, J. E., Texas power and Light Company, Dallas.
Scott, W. A., Bell Telephone of Pennsylvania, Philadelphia.
Scott, D. B., Allis-Chalmers Manufacturing Company, West Allis, Wis.
Seely, S., College of City of New York, New York, N. Y.
Shaffer, L. J., The Ohio Bell Telephone Company, Cleveland.
Shaw, W. A., New England Telephone Company, New Haven, Conn.
Shillington, H. R., Western Electric Company, Cicero, Ill.
Shoemaker, H. E., Ohio Brass Company, Mansfield, Ohio.
Silliman, H. G., City of Seattle Lighting Department, Seattle, Wash.
Silva, M. A., 339 North Claremont Street, San Mateo, Calif.
Simmons, R. W., Brooklyn Edison Company, Brooklyn, N. Y.
Sinclair, L. B., Bethlehem Shipbuilding Corporation, Sparrows Point, Md.
Skarshoug, E. G., 3018 Story Street, Ames, Iowa.
Small, B. I., Simplex Wire and Cable Company, Cambridge, Mass.
Small, E. H., 2015 University Ave., New York, N. Y.
Smith, G. T. (Member), Electric Boat Company, Bayonne, N. J.
Smith, H. D., General Electric Company, Schenectady, N. Y.
Smith, H. R., Allen Bradley Company, Milwaukee, Wis.
Speirs, A. C., 95 South First, West, Tooele, Utah.
Sproul, P. T., Bell Telephone Laboratories, Inc., New York, N. Y.
Squires, J. H., Jr., Westinghouse Electric and Manufacturing Company, New York, N. Y.
Stanilewicz, F. S., Tung-Sol Lamp Works, Inc., Newark, N. J.
Stark, G. F., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Steever, R. G. E., General Electric Company, Schenectady, N. Y.
Steffey, C. D., Commonwealth Edison Company, Chicago, Ill.
Steinke, R. R., General Electric Company, Portland, Ore.
Stephens, A. C. (Member), Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
Stoll, V. B., General Electric Company, Pittsfield, Mass.
Stoller, M. J., 103-02 119th Street, Richmond Hill, N. Y.
Stromquist, T. A., 866 Twentieth Street, Boulder, Colo.
Strobridge, J. H., Southern California Edison Company, Ltd., Long Beach, Calif.
Stone, P. J., Consolidated Edison Company of New York, Inc., New York, N. Y.
Storaasli, B. A., Allis-Chalmers Manufacturing Manufacturing Company, West Allis, Wis.
Summers, C. H. (Member), Florida Power and Light Company, Sarasota.
Swan, H. C., Delco Products Corporation, Dayton, Ohio.
Sweeney, G. E., West Penn Power Company Greensburg, Pa.
Taylor, G., Boston Consolidated Gas Company, Boston, Mass.
Tefft, D. R., United Electric Railways Company, Providence, R. I.
Temple, R. B., General Electric Company, Schenectady, N. Y.
Templeton, R. K., Aluminum Company of America, Alcoa, Tenn.
Thomas, E. W., 900 Flower Avenue, Takoma Park, Md.
Thomas, K. E., General Electric Company, Schenectady, N. Y.
Thomason, J. B., Emerson Electric Manufacturing Company, St. Louis, Mo.
Thompson, H., U. S. Engineers Department, Fort Peck, Mont.
Thompson, H. V., Municipal Airport, Pensacola, Fla.
Tilton, R. D., Allis-Chalmers Manufacturing Company, Norwood, Ohio.
Timberman, F. C., Allis-Chalmers Manufacturing Company, West Allis, Wis.
Tollefsen, A. B., Jr., Teletype Corporation, Chicago, Ill.
Torre, E. L., General Electric Company, Schenectady, N. Y.
Tower, D. K., General Electric Company, Schenectady, N. Y.
Townsend, H. D., Electric Controller and Manufacturing Company, Cleveland, Ohio.
Trigg, J. E., Ohio Power Company, Coshocton, Ohio.
Trischka, J. W., General Electric Co., Schenectady, N. Y.
Turecki, W., 756 Oliver Street, North Tonawanda, N. Y.
Tusin, A. S., Ohio Edison Company, Akron, Ohio.
Unangst, G. W., Ohio Power Company, Coshocton, Ohio.
Vallette, C. T., Western Electric Company, Inc., Chicago, Ill.
Vantine, H., Jr., Federal Telegraph Company, Newark, N. J.
Vasconcelos, J. I., General Electric Company, Pittsfield, Mass.
Vater, G. A., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Viverette, C. E., Carolina Power and Light Company, Fayetteville, N. C.
Wade, C. F., International Business Machines Corporation, Endicott, N. Y.
Wadlin, M. L., Highland, N. Y.
Wagner, K. B., General Electre Company, Schenectady, N. Y.
Wait, D. J., Federal Power Commission, New York, N. Y.
Wallace, H. L., Jr., International Business Machines Corporation, Endicott, N. Y.
Wallace, R. H., Sperry Products, Inc., Brooklyn, N. Y.
Walsh, W. J. J., 1409 Monroe Street, Corvallis, Ore.
Ward, C. L., Hartford Electric Light Company, Hartford, Conn.
Ward, J. E., Jr., General Electric Company, Schenectady, N. Y.
Warrick, V. H., Howard University, Washington, D. C.
Weadon, R. W., Department of City Transit, Philadelphia, Pa.
Weil, W. S., Jr., General Electric Company, Philadelphia, Pa.
Welser, H. T., 124 West Eighth Avenue, Columbus, Ohio.
Weppler, H. E., Michigan Bell Telephone Company, Holland.
West, L. G., Western Electric Company, Chicago, Ill.
Wey, G. J., Westinghouse Electric and Manufacturing Company, Newark, N. J.
Whiteley, E., Canadian General Electric Company, Ltd., Peterboro, Ont., Canada.
Whysong, J. L., Public Service Company of Northern Illinois, Chicago, Ill.
Willberg, V. R., Crocker-Wheeler Electrical Manufacturing Company, Ampere, N. J.
Williams, C. G., Bell Telephone Company of Pennsylvania, New Castle.
Williams, N. A., Ohio Edison Company, Youngstown.
Wilson, J. A., Public Service Electric and Gas Company, Newark, N. J.
Winter, W. W., Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
Winzeler, J. W., Goodman Manufacturing Company, Chicago, Ill.
Wood, R. H., Georgia Power Company, Carrollton, Ga.
Woodrow, R. J., Philadelphia Electric Company, Philadelphia, Pa.
Woodruff, C. W., Texas Power and Light Company, Dallas.

Work, W. W., General Electric Company, Schenectady, N. Y.
Wright, L. L., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Wright, R. W., Elsbert Manufacturing Company, Chicago, Ill.
Yanulavich, P. W., 116 West 73d Street, New York, N. Y.
Yelsky, B., 1503 Eastern Parkway, Brooklyn, N. Y.
Young, R. E., Public Service Company of Northern Illinois, Chicago.
Yosovitz, I. L., Buffalo Niagara Electric Corporation, Niagara Falls, N. Y.
Zacherle, B. H., United Engineers and Constructors, Inc., Philadelphia, Pa.
Zlatin, N., Liebel-Flarsheim Company, Cincinnati, Ohio.
Zupanec, W. I., General Electric Company, Schenectady, N. Y.

Total, United States and Canada—451

Elsewhere

Aguiar, A. L., Department of Commerce, Havana, Cuba.
Aldridge, R. F., Chile Exploration Company, Chuquicamata, Chile.
Chabook, R. D., The Nizam's Government Power House, Raichur, India.
Ehlers, N. A., Box 85, Parral Chih, Mexico.
Green, P. T., Box 213, Balboa, Canal Zone.
Hewlett, E. W. (Member), Central Electricity Board, London, S. W. 1, England.
Izquierdo, F. P., Treasury Dept., Havana, Cuba.
Jain, A. P. (Member), Delhi Municipality, Delhi, India.
Krishna, N. R., Tata Power Company, Ltd., Bombay, India.
Lagomasino, J., Jr., Comp. Cubana de Elect., Havana, Cuba.
Leung, C. W., 85 Wongneichong Road, Happy Valley, Hongkong, China.
Mukerjee, D. C. (Member), Water Works, Aligarh, U. P., India.
Perouse, M. J., 4 Quai Perrache, Lyon, Rhone, France.
Pickworth, E. W., British Sangamo Company, Ltd., Enfield, England.
Vakil, D. L., Godhra Electric Company, Ltd., Bhavnagar, India.
Walker, G. N., Ensign Lamps, Ltd., Parade, Birmingham 3, England.

Total elsewhere—16

Addresses Wanted

A list of members whose mail has been returned by the postal authorities is given below, with the addresses as they now appear on the Institute record. Any member knowing of corrections to these addresses will kindly communicate them at once to the office of the secretary at 33 West 39th St., New York, N. Y.

Charlton, H. C., 4827 Wilson Avenue, Montreal, Que., Canada.
Cooper, Peter G., 50 Stanton St., Schuylkill Haven, Pa.
Dadashev, Musa, 32 Zamkovaja, Ulitsa, Baku, U.S.S.R.
Fassett, Frank C., 100 Seward Ave., Detroit, Mich.
Gregory, G. A., 1217 Jefferson Street, Olympia, Wash.
Hall, John R., 1464 S. 74th St., West Allis, Wis.
Herr, Melvin D., South 228 Lincoln St., Spokane, Wash.
Macomber, George S., Federal Power Commission, Washington, D. C.
McLean, Lee Vance, 1926 North Blvd., Baton Rouge, La.
Roberts, William N., 4175 Springle, Detroit, Mich.

10 Addresses Wanted

Engineering Literature

Among the new books received at the Engineering Societies Library, New York, recently are the following which have been selected because of their possible interest to the electrical engineer. Unless otherwise specified, books listed have been presented gratis by the publishers. The Institute assumes no responsibility for statements made in the following outlines, information for which is taken from the preface of the book in question.

INVENTIONS and THEIR MANAGEMENT By A. K. Berle and L. S. De Camp. Scranton, Pa. International Textbook Company, 1937. 733 pages, illustrated, tables, leather, $4.50. Describes the problems confronting inventors and business men in developing ideas into industrial property of value. The various pitfalls and special points are illustrated by actual cases.

HOW to MAKE ALIGNMENT CHARTS. By M. G. Van Voorhis. New York and London, McGraw-Hill Book Company, 1937. 114 pages diagrs., charts, tables, 9 by 6 inches, cloth, $2.50. A practical implement for engineers and designers, showing how to make nomographic or alignment charts for the solution of engineering and other formulas.

EVERYDAY SCIENCE. By A. W. Haslett. New York, Alfred A. Knopf, 1937. 305 pages, 9 by 6 inches, cloth, $2.75. Intended to give the layman definite, factual information on various phases of research and provide a background on which to base opinion and discussion.

ELECTRICITY and MAGNETISM. By S. G. Starling. New York and London, Longmans, Green and Company, 1937. 630 pages, illustrated, 9 by 6 inches, leather, $4.00. New edition following the lines of its predecessors. Introduces new topics, such as cosmic rays, the neutron, positron, and induced radioactivity.

ATOMIC ARTILLERY, Modern Alchemy for Every Man. By J. K. Robertson. New York, D. Van Nostrand Company, 1937. 177 pages, illustrated, 8 by 5 inches, cloth, $2.25. A book on atom splitting for the layman or young student. Tells the story of electrons, protons, positrons, photons, neutrons, and cosmic rays, and explains the methods and apparatus for shooting atoms and transmuting elements.

ASTRONOMY for the MILLIONS. By G. Van Den Bergh, translated from the Dutch by J. C. H. Marshall and T. de Vrijer. New York, E. P. Dutton & Company, 1937. 370 pages, illustrated 9 by 6 inches, cloth, $3.50. Another presentation of a scientific subject to the layman.

CARBON BRUSHES. By J. Neukirchen, translated from the German by E. I. Shobert II. St. Mary's, Pa., Stackpole Carbon Company, 1937. 166 pages, illustrations, 9 by 6 inches, leather, $3.00, (available from the Telegraph Press, Harrisburg, Pa.). Discusses the problems associated with the collection and commutation of electric current. Arcing, electrolysis, polish, selective action, wear, vibration, interpoles, and other matters are discussed.

ASTM STANDARDS on RUBBER PRODUCTS, prepared by Committee *D*-11 on Rubber Products. Methods of Testing, Specifications. November 1937. Philadelphia, American Society for Testing Materials, 1937. 238 pages, illustrated, 9 by 6 inches, paper, $1.25. Gives the standards in their latest approved form. Presents 15 methods of testing and 10 specifications, covering rubber and rubber products.

Book of ASTM TENATIVE STANDARDS, 1937. Philadelphia, American Society for Testing Materials, 1937. 1629 pages, diagrams, tables, 9 by 6 inches, paper, $7.00. Annual list of tentative specifications, methods of testing, definition of terms, and recommended practices covering materials of engineering and the allied testing field.

DIAGONAL FUNCTIONS and THEIR OPERATION. By C. L. Clarke. Newton, Mass., Chas. L. Clarke, 1937. Charts, tables, 11 by 8 inches, cloth, $5.00. Describes a new branch of applied mathematics. The foundation for diagonal functions is the half-cycle trigonometrical sine curve, further dealt with in offset and sheared form, and all referred to rectangular axes with an origin common to them and the base of the sine curve midway between them.

ELEMENTARY THEORY of OPERATIONAL MATHEMATICS. By E. Stephens. New York and London, McGraw-Hill Book Company, 1937. 313 pages, tables, diagrams, 8 by 6 inches, cloth, $3.50. An extension of the fundamentals of Heaviside's work in operational mathematics. Describes the simplification of the operators in differential and integral calculus by algebraic methods, and reinterprets the resulting forms as operators for easier handling.

(The) ENGINEERS' WHO'S WHO, 1937, compiled by M. E. Day. London, D. M. A. Co., Ltd., 1937. 183 pages, 9 by 6 inches, cloth, 20s. A biographical directory of 1,300 men of importance in engineering in Great Britain and Ireland.

FUNDAMENTAL PRINCIPLES of QUANTUM MECHANICS. By E. C. Kemble. New York and London, McGraw-Hill Book Company, 1937. 611 pages, diagrams, tables, 10 by 6 inches, cloth, $6.00. The basic technique of elementary (nonrelativistic) quantum mechanics, including its philosophical and mathematical background. Treats of wave mechanics, dynamical variables and operators, matrices, atomic structure, and related problems.

GLOSSARY of PHYSICS, compiled and edited by L. D. Weld. New York and London, McGraw-Hill Book Company, 1937. 255 pages, 8 by 5 inches, cloth, $2.50. Contains definitions of over 3,200 physical terms, including many from adjacent fields that are often used in physical literature.

HOW to HANDLE GRIEVANCES. By G. Gardiner. New York, 219 East Forty-fourth Street, Elliott Service Company, 1937. 52 pages, 8 by 5 inches, leather, $0.60; paper, $0.45. A presentation in practical form, of the fundamental principles found effective in the handling of workmen's grievances.

HOW to USE PICTORIAL STATISTICS. By R. Modley. New York and London, Harper and Brothers, 1937. 170 pages, illustrated, 10 by 6 inches, cloth, $3.00. Presents the technique of producing pictorial charts as devised by Doctor Otto Neurath, of Vienna.

MANAGERIAL CONTROL, Instruments and Methods in Industry. By J. G. Glover and C. L. Maze. New York, Ronald Press Company, 1937. 574 pages, diagrams, tables, 8 by 5 inches, cloth, $4.50. Discusses means and methods for obtaining greater efficiency in manufacturing processes. The major part of the book is devoted to cost control in the various phases of industrial activity.

MUSIC and SOUND. By L. S. Lloyd, with a foreword by Sir Wm. Bragg. New York, Oxford University Press, 1937. 181 pages, illustrated, 9 by 6 inches, cloth, $3.50. The author, who is both a physicist and a musician, has written this volume especially for students of music, and approaches the relation between acoustics and music from the viewpoint of the history of musical composition.

SEGMENTAL FUNCTIONS, Text and Tables. By C. K. Smoley. Scranton, Pa., C. K. Smoley and Sons, 1937. 184 pages, diagrams, tables, 7 by 5 inches, leather, $5.00. Description of a practical method for solving problems dealing with parts of a circular segment. The segmental functions are ratios of the various linear measurements of a segment and most of the book consists of logarithmic tables for these functions.

La TRACTION ÉLECTRIQUE et le CHEMIN DE FER. (volume 1. Cinématique et Dynamique de l'Exploitation des Chemins de Fer.) By H. Parodi, A. Tétrel, and P. Richemond. Paris, Dunod, 1935. 559 pages, diagrams, tables, 10 by 7 inches, paper, 148 frs.; bound, 158 frs. Gives special attention to the problems accompanying the use of electric power and the new methods of railway operation.

TELEVISION, a Guide for the Amateur. By S. A. Moseley and H. McKay. New York, Oxford University Press, 1936. 144 pages, illustrated, 9 by 5 inches, cloth, $2.00. Sets forth the principles of television and their practical applications. Intended for the nontechnical reader.

STATISTICAL YEAR-BOOK of the WORLD POWER CONFERENCE, Number 2. Edited by F. Brown. London, World Power Conference; American Committee, World Power Conference, Interior Building, Washington, D. C., 1937. 132 pages, tables, 11 by 9 inches, cloth, 20s. Statistics of the resources, production, stocks, imports, exports, and consumption of power, and power sources in all countries from which information was available, mainly for 1934–35.

SOUND, ELECTRICITY and MAGNETISM, LIGHT. (Physics for Technical Students.) By W. B. Anderson. Third edition. New York and London, McGraw-Hill Book Company, 1937. 361–796 pages, illustrated, 9 by 6 inches, cloth, $2.50. The material is of a general, elementary nature, for the use of undergraduates, with brief treatment of various modern developments.

Engineering Societies Library

29 West 39th Street, New York, N. Y.

MAINTAINED as a public reference library of engineering and the allied sciences, this library is a co-operative activity of the national societies of civil, electrical, mechanical, and mining engineers.

Resources of the library are available also to those unable to visit it in person. Lists of references, copies or translation of articles, and similar assistance may be obtained upon written application, subject only to charges sufficient to cover the cost of the work required.

A collection of modern technical books is available to any member residing in North America at a rental rate of five cents per day per volume, plus transportation charges.

Many other services are obtainable and an inquiry to the director of the library will bring information concerning them.